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SHELLFISH CONSERVATION AND SEWAGE DISPOSAL.

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Something like two centuries ago a noted British satirist made the statement that the man who first ate an oyster possessed a considerable degree of courage. This remark of such delicious facetiousness lives even today. Inasmuch as the first reference to a possible connection between a typhoid fever outbreak and oysters dredged from polluted sources was made by Dr. Pasquier about one hundred years ago, it is probable that Swift's humorous arraignment of the succulent bivalve was inspired by its unsightly, flaccid appearance, and the fact that the first man to eat one probably, like the somewhat less famous Bosco, "Ate it alive."

Of the nutritious qualities of shellfish there can be no question. Of the palatability of raw oysters and clams we are equally certain, and of those who profess not to fancy them in this form the vast majority, in all human probability, dodge the issue for the reason that in their hearts they suspect the kindly nutrient intentions of the passive victim, or prefer it cooked.

The aborigines made free use of shellfish as food, and we know that the Pilgrim Fathers derived no little benefit from them in the same connection. But in those days, there were no huge sewer outfalls spewing their noisome burdens over the shellfish grounds, nor did the natives make a habit of gathering oysters and, before consumption, "fattening" them in polluted brackish or fresh water. They seem to have been content with the raw material, so to speak, not being particularly interested in the bulk or appearance of the oyster itself.

Today conditions are different. The shellfish industry has grown until the value of the total annual output of nearly 40,000,000 bushels amounts

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approximately to $20,000,000, three fourths of which is controlled by New York, Virginia, Connecticut, Maryland, New Jersey, Rhode Island, Louisiana and Massachusetts. Sanitary conditions naturally have changed also. Where shellfish formerly grew in a naturally pure state there now often discharge huge sewer outfalls, polluted rivers, the effluents of sewage treatment works, and sewage in more or less concentrated form is carried directly or indirectly over the shellfish grounds by winds and currents. The oyster filters enormous quantities of water, and under such deplorable conditions it is but natural that in so obtaining its food supply much sewage matter is taken in and retained by it.

Is the oyster extravagantly maligned or is it an even worse menace to the public health than it is generally supposed to be? There can be no question that, growing in polluted waters, the oyster will take in and retain pathogenic germs, if such are present in the water. Although typhoid germs do not multiply within the body of a healthy oyster, but live there in steadily decreasing numbers, the evidence is pretty strong that in dead oysters this germ will actually flourish. Thus it is easily conceivable that one dead oyster may contaminate scores of perfectly good oysters growing in the same vicinity, or stored and transported in the same receptacle.

It is equally certain that polluted oysters can cause, and repeatedly have caused, epidemics of typhoid fever and other intestinal disorders. The proof is thus afforded that polluted oysters can produce disease in the human organism, but the far greater and more serious aspect of polluted oyster consumption refers to such isolated and sporadic cases of sickness as are traceable to no specific source but which plainly may have emanated from unclean oysters. There is no way even of estimating the number of deaths which annually may be caused in this way; but it may well be many times that disclosed by well-defined epidemics traced with certainty to polluted oysters.

How can the oyster be protected from dangerous pollution? This is no simple question. The writer speaks feelingly on this point for the reason that about a dozen years ago he experienced the first of three attacks of gastro-enteritis, of which the one mentioned was traced with positiveness to oysters dredged from one of the most famous oyster grounds in the world, and consumed in an establishment of international reputation for the excellence of its sea-food, shellfish in particular.

Over three hundred years ago we were advised to eschew the consumption of oysters in every month that has not an R in its name. Of recent years we hear much of the possibilities of "oyster hibernation." The theory is that during the cold months of the year the shell closes tightly, and the oyster passes into a "sleeping" state, only to open and resume its normal functions with the advent of warm weather. Hence oysters

dredged in the cold months supposedly are safer to eat than in the warm months. Naturally this feature is of much less significance in the warm waters of the South, but seems to be worthy of consideration in connection with oyster harvesting in the colder northern waters, the most serious difficulty being, however, that in some northern waters the shellfish grounds are frozen over at the time when the oyster may be hibernating, making harvesting at such times a virtual impossibility. Furthermore, obstructions preventing the complete closing of the shell, or the occasional casual opening of the shell, would tend to minimize the salutary effect of hibernation.

Polluted oysters cannot always be made entirely safe for consumption even by cooking, and still remain palatable. Heat, as ordinarily applied in cooking shellfish, does not destroy all the germs they may contain, for to do so would be to impart to them the consistency of rubber. It is a well-known fact that among connoisseurs the best oyster or clam stews are the so-called "one minute" variety wherein the shellfish are first brought to a simmer in a pan, the milk being then immediately added, and the whole brought to a first boil, when the stew is ready. The heat so applied does not reach all parts of the bivalve, but pleasantly warms it through.

Without placing an utterly unbalanced financial burden on the responsible communities, how may shellfish grounds be protected from contamination by the sewage of such communities? Shellfish are most profitably grown in localities where the intermingling of salt and fresh water is best suited to their taste, and where the food supply is suitable and ample. The best grounds are found in the mouths of rivers and bays near the ocean, and it is indeed unfortunate for the industry that such waters are usually subject to continuous, or at least intermittent, pollution by the sewage of cities and towns located directly on or tributary to such waters. An ideal oyster ground is Jamaica Bay near New York, from whence come over 25 per cent. of the total oyster crop of New York state, yet some 40,000,000 gallons of sewage enter this bay each day, and the volume of sewage is steadily increasing.

Until the dream of the idealist is realized, and all sewage is made innocuous before discharge, there seems to be little hope that shellfish, where usually cultivated, are not to be considered to be and still remain a potentially dangerous article of diet for human consumption unless perhaps, after being harvested, they are removed to an unpolluted water and there allowed a period for self-purging before being placed on the market. It seems to be reasonably certain that polluted shellfish, when placed in constantly changing, unpolluted water, will purge themselves of impurities in from one to two weeks. This department of oyster cultivation and harvesting has received altogether too little attention in the past.

This refinement in the preparation of shellfish for the market may not

be the ultimate answer to the problem, but it deserves exhaustive study. If the results of such studies prove favorable there should not be a sensible oysterman who would not gladly adopt it, for with the coöperation of a supervising federal or state authority he would then be enabled to furnish for the market certified shellfish, and the thinking consumer could never object, but rather should heartily approve of an increase in the selling price sufficient to cover the cost of such treatment, being assured of the purity of the food he is consuming.

Until prohibited by federal or state authorities, shellfish polluted and clean will continue to appear on the table, and even if forbidden for public sale they will still be used. Except in special, well adapted cases, it is impossible on financial and other grounds absolutely to conserve the purity of shellfish by sewage treatment. Complete treatment of the sewage entering waters which flow over shellfish layings will improve existing conditions, and in special cases almost, if indeed not entirely, remove the existing danger; but to be thoroughly effective a condition is required which is seldom if ever found at the sewage treatment works today. There would be required not only extreme conscientiousness in the operation of the sewage treatment works, paralleling the vigilance with which good water filtration works are watched, but also interstate coöperation, the whole order of affairs being supervised by a supreme authority vested by law with power to approve or condemn.

The conservation of the shellfish industry is a difficult problem, made so by the fact that common law rights of sewage disposal into the sea and its estuaries have been and are being extensively utilized. To set these conditions back a century solely for the sake of conserving the oyster industry, where no other offense is created, is a matter which, if pressed, will engage active sanitary, financial and legal minds for many years to come.

THE GERMICIDAL ACTION OF SUNLIGHT UPON BACTERIAL SPORES.

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The germicidal action of sunlight upon bacteria has been extensively studied by a number of investigators. A review of these investigations was given by the writer in an earlier paper (Weinzirl, Jour. of Inf. Dis. Sup. No. 3, p. 128, 1907). In this paper it was shown that when bacteria are freely exposed without the intervention of culture media, direct sunlight kills most vegetative forms in the remarkably short time of two to ten minutes. While the facts concerning the vegetative forms have been worked out pretty thoroughly, the same cannot be said regarding spore forms. Among the earlier workers in this field Arloing first, and Ward later, worked with anthrax spores, exposing them in gelatin and agar plate cultures. Arloing (Comp. rend. 1885) found that twenty-five to thirty hours were required to kill the bacilli in plate cultures, but if spores were exposed in test tubes filled with bouillon, he obtained the curious result that they were killed in two hours. If the spores in bouillon were kept on ice to prevent germination, it required the longer period to kill them. Thus he was led to the anomalous conclusion that spores are killed more readily than vegetative forms. Ward (Proc. Roy. Soc. 1890–4) also experimented with anthrax and at times used spores only. He found that in March one-half to one hour exposure to sunlight caused inhibition of growth, and one to one and one-half hours' exposure showed the bacteria partly killed out. He found it impossible to determine the exact time required to kill because of the varying intensity of the light at different times. Apparently it required several days to completely kill his cultures. He too found that spores were more easily killed than vegetative forms, and offered the explanation that this might be due to the greater amount of fat contained in the spores. When spores were sealed in a vacuum, they were not killed as quickly as in air. So far as the writer is aware, no other investigations have been published relative to this problem.

In view of the fact that the above results are diametrically opposed to what would be expected, judging from the well-known resistance of spores to all other destructive agents, and also because the technique employed was not the best adapted to the purpose, it seemed desirable to re-open the question and work by means of the direct exposure method devised

by the writer. To restate the method briefly, bacteria or spores are brought into a uniform suspension in physiological salt solution; by means of a platinum loop a droplet of this suspension is placed upon sterile paper or glass; the film is then exposed to sunlight in sterile petri plates with the covers on or removed as conditions may determine. The advantage of this technique is obvious for the purpose in hand. First, the full effect of the sunlight is secured, there being no medium intervening to absorb the light rays, especially the chemical rays. Secondly, the germicidal substances such as hydrogen peroxide, ozone, formaldehyde, phenols, organic peroxides, etc., formed from the medium under the influence of the chemically active rays, are not produced, and hence their action, always present in the earlier experiments, can be eliminated, thus giving the effect of sunlight alone. Thirdly, a special advantage exists in the case of testing out spores. If spores are exposed in a culture medium they absorb moisture and may even germinate before the end of the experiment. Undoubtedly the naked protoplasm of the germinating spore would be more vulnerable than either spores or mature vegetative forms having a protective cell wall.

Time Required by Sunlight to Kill Spores.

The attempt was made first of all, to determine the time required by direct sunlight to kill spores. For this purpose cultures approximately one month old were used. Emulsions approximating a 24-hour-old bouillon culture of typhoid were made in salt solution, then heated at 80° C. for 10 minutes, cooled, and spread upon the sterile paper slips in petri dishes. When the water had evaporated, the plates containing the slips were exposed to direct sunlight as nearly vertically as practicable. These paper slips, after insolation, were placed either in petri dishes and covered with agar, or in bouillon tubes, and after incubation, examined for growth. In this manner the following results were secured.

TABLE 1.—SHOWING THE TIME REQUIRED FOR DIRECT SUNLIGHT TO KILL BACTERIAL SPORES.

Organism.	Date.	Time exposed (hours):	
		Growth.	No growth.
Bact. anthracis	Dec. 26	0.5, 1, 2, 3	.....
	" 30	3, 4.5, 6.5	8.5
	April 1	0.5, 1	.....
	" 2	0.6, 1.3	3, 6
	" 3	0.3, 0.6, 2, 3	4
	" 7	1, 1.5, 2	2.5, 3, 3.5
	May 17	0.5, 1, 1.5	2.5
	" 19	0.5, 1, 1.5, 2, 2.5	.....
	" 28	1, 1.5, 2, 4	.....

TABLE I.—(*Continued*).

Organism.	Date.	Time exposed (hours).	
		Growth.	No growth.
B. megatherium	Dec. 26	0.5, 1, 2, 3	.....
	" 30	3, 4.5, 6.5	8.5
	July 29	4	2, 6
		2	4, 6
		2	4, 6
		2	4, 6
		2, 4	6
	" 31	2	4, 6
		2, 4	6
		2, 4	6
		2, 4	6
Bact. mycoides	" 1	2	6.5
	" 5	1, 2	5
	" 5	1, 2	5
	" 5	1, 2, 5	0
	" 29	Control	2, 4, 6
		"	2, 4, 6
		"	2, 4, 6
		"	2, 4, 6
		"	2, 4, 6
	Aug. 1	1	3, 5
		1	3, 5
		1	3, 5
B. subtilis	Dec. 26	0.5, 1, 2, 3	.....
	" 30	3, 4.5, 6.5, 8.5	.....
	July 1	2	6.5
	" 5	1, 2, 5	.....
		1, 2	5
		1, 2, 5	.....
	" 7	1, 2, 5	.....
		1, 2, 5	.....
	" 8	2	5
		2	5
		2	5
B. vulgatus	" 8	2	5
		2	5
		2	5
	" 31	2	4, 6
		2	4, 6
		2	4, 6
		2	4, 6
		2	4, 6

As the table shows, five different species of spore formers were tested

out, viz., *Bact. anthracis*, *B. megatherium*, *Bact. mycoides*, *B. subtilis*, and *B. vulgatus*. In only a vew instances were all the spores killed within 2 hours; usually a longer time was required, the longest being 8.5 hours. A rough average would then give 5 hours as the approximate time required to kill bacterial spores.

If we now examine the time required by the various species investigated, no very marked difference appears; *Bact. mycoides* is apparently the least resistant, while *B. megatherium* seems to possess the greatest resistance.

Relative Resistance of Spores and Vegetative Bacteria.

If we now compare the results for spores with those obtained for non-spore forming bacteria (Weinzirl, loc. sit.) then it is perfectly plain that the spores have the greater resistance just as we should expect; the non-spore formers are killed commonly in 2 to 10 minutes, while the spores require 2 to 8 hours. However, some micrococci, especially soil and air forms, show an unusual resistance to sunlight, requiring in one instance more than 1.5 hours to kill. Hence it might be possible for the vegetative stage of spore formers to also show an unusually high resistance and possibly, too, as Ward and Arloing found, that they are even more resistant than their spores.

In attempting to solve this problem, ideal conditions would be met if we could compare pure spores, and pure vegetative cultures. A pure spore culture was obtained by heating the suspensions at 80° C. for 10 minutes. To obtain pure vegetative forms was not so easily accomplished. *Bact. anthracis*, Pasteur found, does not procure spores under anaërobic conditions; accordingly this organism was grown under an atmosphere of hydrogen, but a spore-free culture could not be obtained after repeated trials; when exposed they gave the same results as spores; when microscopically examined, occasional spores were seen; and when heated to 65° C. for 80 minutes, sub-cultures gave growth. Hence, this plan failed of its purpose. The attempt to gain a spore-free culture by growing anthrax at 43° to 45° C., according to Pasteur's method, also failed. Even if sporeless cultures could have been obtained by this method, their vitality was so impaired as to make them uncomparable to vigorous forms. The next move was to grown sporeless cultures by making transfers several times a day and then using a very young culture; when heated to 80° C. for one hour, the subculture grew, showing that spores were still present.

In the earlier work when anthrax was grown in an atmosphere of hydrogen, the cultures were left at room temperature. It seemed wise to try blood heat also. Accordingly the cultures were placed at 37° C., and this proved more successful. Three experiments were made on this basis, giving the following results:

From the trials made, it would appear that the bacilli or vegetative forms are less resistant than the spores. Since the direct method could not

TABLE II.—GIVING COMPARATIVE RESULTS FOR ANTHRAX SPORES AND FOR VEGETATIVE ANTHRAX WHEN EXPOSED TO SUNLIGHT.

Date.	Culture.	Time exposed (hours): Growth.	No growth.
May 17	Anthrax spores	0.2, 0.5, 1, 1.5, 2.5	.....
	" bacilli	0.2, 0.5, 1	1.5, 2.5
" 19	" spores	0.5, 1, 1.5, 2.5	.....
" 19	" bacilli	0.5, 1	1.5, 2, 2.5
" 28	" spores	1, 1.5, 2, 4	.....
	" bacilli	1, 1.5	2, 4

be applied to other spore formers, it had to be abandoned for the indirect; that is, if it can be shown that spore cultures are not less resistant than mixed cultures, then it is a fair inference that vegetative forms are not only not more resistant, but probably less resistant.

The results of the indirect method cannot be entirely satisfactory for obvious reasons. The heating of the spores might make them less resistant than the unheated cultures; again, a clump of bacterial threads may serve to protect spores underneath and thus introduce irregularities; and if the same culture is used for both trials, then the vegetative forms may be weakened by age. From the results given there does not appear to be any marked tendency of increased resistance for the vegetative forms, and therefore, we may infer that the vegetative forms are not more resistant.

TABLE III.—GIVING TIME REQUIRED BY SUNLIGHT TO KILL SPORES (HEATED) AND SPORES AND VEGETATIVE FORMS.

Organism.	Condition.	Date.	Time exposed (hours): Growth.	No growth.
B. megatherium	spores only	July 31	2	4, 6
	"		2, 4	6
	"		2, 4	6
	"		2, 4	6
	"		.....	2, 4, 6
	spores and bacilli	"	.....	2, 4, 6
	" "		.....	2, 4, 6
	" "		2	4, 6
	" "		.....	2, 4, 6
	" "		2	4, 6

TABLE III.—(*Continued*).

Organism.	Condition.	Date.	Time exposed (hours):	
			Growth.	No growth.
Bact. mycoides	spores only	Aug. 1	1	3, 5
	"		1	3, 5
	"		1	3, 5
	spores and bacilli		1	3, 5
	" "		1	3, 5
	" "		1	3, 5
B. vulgatus	spores only	Aug. 22	1, 3	5
	"		1, 3	5
	"		1, 3, 5	.....
	"		1, 3	5
	spores and bacilli	"	1, 3, 5	.....
	" "		1, 3, 5	.....
	" "		1, 3, 5	.....
	" "		1, 3, 5	.....
B. subtilis	spores only	"	1, 3, 5	.....
	"		1, 3, 5	.....
	"		1, 3, 5	.....
	"		1, 3, 5	.....
	spores and bacilli	"	1, 5	3
	" "		1	3, 5
	" "		1	3, 5
	" "		1, 5	3

Summary.

It seems likely, then, that the earlier workers using a medium in which to expose the spores, probably failed to prevent their germination, and in this way failed to get the true resistance of spores. By planting them on paper and exposing them directly, this complication is avoided, the true resistance is shown, and this corresponds to their well-known superior resistance to other killing agents. The time required to kill bacterial spores varies from 2 to 8 hours, or about 60 times that required to kill non-spore forming bacteria.

THE DESTRUCTION OF BACTERIA THROUGH THE ACTION OF LIGHT.

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It is generally assumed that artificial light is more harmful to the eyes than daylight. This has been ascribed by many to the quality of the artificial light rather than to the faulty distributions and intensities which seem quite as likely to be the causes of the observed effects. That this harmfulness may be due to ultra-violet radiation in the light seems, at first sight, plausible, particularly in view of the known facts concerning the bactericidal action of these radiations. As the opening step in a series of investigations on the true cause of the difference in the physiological action of natural and artificial illumination, it seemed desirable to determine definitely the wave-lengths which accomplish the destruction of bacteria. Previous investigators generally have made use of full sources of light, for example, the carbon arc, iron arc or mercury arc, without any analysis of the radiation. The use of a quartz spectroscope and accessories naturally suggests itself as a means of getting more exact information.

The objects of this work may be specifically stated as follows: To determine precisely the wave-lengths most destructive of bacteria; to find out whether or not simultaneous irradiation with rays of greater penetration is essential to the bactericidal action; and to investigate the effect of dissolved food materials, or other material, on the resistance of bacteria.

A large amount of work has been done on the destructive effects of light beginning with Downes and Blunt (77) and including DuClaux (85), Roux (87), Arloing (85), Buchner (92), Marshall Ward (93), Ledoux Lebard (93), Richardson (93), Dieudonne (94), Finsen and his pupils (99–07), Jodlbauer and his pupils (05–09), and Cernovdianu and Henri (10). It is not necessary to give abstracts of all of the papers above referred to. To sum up the entire series, the conclusion finally reached is that light containing radiations of a length less than 2,800 Angstrom units will, after a sufficient time, kill bacteria. No investigator whose works I have been able to locate has analyzed the radiation used with any kind of spectrometer and in only one case (Henri) have filtering screens been used. The work of the Finsen school is particularly interesting because of its application to the treatment of cutaneous bacterial diseases as lupus vulgaris and lupus erethymatosus (due to the tubercle bacillus). The light used for this purpose is the so-called Finsen Ray (Violet Ray, or Actinic Ray). To pro-

duce curative effects, the entire radiation of a carbon arc must be used, the ultra-violet alone being ineffective, according to Finsen. Further, the light must be concentrated by condensing lenses. In these lamps, the light-path includes a system of quartz lenses and, in addition, ten or twelve inches of distilled water which must absorb all of the far ultra-violet and infra-red. The bactericidal effect must therefore be ascribed to the intermediate waves. The exposures made are for a minimum of seventy minutes. There can be no question of the fact that cases of lupus have been cured by the repeated use of this light.

Within the last three years the Cooper-Hewitt Company, under the direction of Doctors Henri, Hebronner and Recklinhausen, have produced a water sterilizer making use of a quartz mercury arc—a source particularly rich in ultra-violet rays. The published advertisements claim that with an expenditure of $\frac{3}{4}$ of a kilowatt, 5,000 gallons per hour can be sterilized completely. These sterilizers are in use on a large scale in the city water works of Luneville (France). In this apparatus the water flows over a partition in a thin sheet at a distance of a few centimeters from a quartz lamp of the same type as one used in this investigation. The effects are ascribed to the ultra-violet rays in the light. No screens of any kind are used.

Any study of the destruction of bacteria must consider the following factors:

(1) Character of the medium containing the organisms at the beginning of the test, whether solid or liquid, nutrient or non-nutrient, absorbing or non-absorbent, oxygenous, or not—also the changes which may be produced in the medium due to the action of the light.

(2) The presence or absence of protective layers due to the medium or to superficial layers of bacteria.

(3) The character of the radiation (a) wave length, (b) intensity, (c) heat content.

(4) Time of radiation.

In this investigation these factors were taken care of severally as follows: (1) As a solid medium agar-agar was used; as liquid media both normal salt solution (non-nutrient) and water containing dissolved food materials. No investigation of the effect of the radiation on the medium was made. Agar is highly absorbent and the only effect to be anticipated in the water is through the production of hydrogen peroxide and the amount of this has been determined by other investigators to be negligible. (2) On agar the presence of a protective layer of the medium was avoided by using surface colony bacteria only. The probability of the occurrence of superficial growths serving to protect more deeply buried bacteria was minimized by exposing the plates immediately after inoculation. (3) The character of the radiation was altered in intensity by using various current

strengths with an iron arc and by using a mercury arc on parallel tests. For each source different distances were used. The radiation was analyzed with a two-prism quartz spectroscope and the wave-lengths exactly determined by comparison with known lines in the mercury arc spectrum. Glass screens of different thicknesses were employed when the work was done at short distances. The direct heating effects were avoided, where necessary, by water cooling the exposed plates. (4) Various times of exposure were made ranging from ten seconds to three hours according to circumstances.

As stated above two sources of radiation were used—the iron arc and the quartz mercury arc. The iron arc was a right-angled hand lamp with half-inch wrought iron electrodes turned to points—the positive pole at 30 degrees, the negative at 15 degrees. The lamp was run on a 110-volt direct current circuit under various current strengths ranging from three to twenty. The current strengths were adjusted by means of a series rheostat. The mercury lamp was a quartz Cooper-Hewitt arc and was operated on the same circuit, *i. e.*, 110-volt direct.

The lamps were supported before an adjustable slit which was kept 2.5 cm. by .05 cm. at all times. The light was collimated by a quartz lens 3.8 cm. in diameter and 25 cm. in focal length and passed through a system of two 60-degree quartz prisms 5 cm. in altitude (cut with their axes perpendicular to their bases). The dispersed light was focused by a second quartz lens similar to the collimating lens and gave a spectrum between (from the visible end of the red to the limit of the ultra-violet) 12.7 cm. and 15 cm. in length. This spectrum could be focused very sharply on a screen and, though curved and somewhat distorted because of the aberration of the lenses, gave excellent definition of closely adjacent lines. The spectral band was, of course, sharply curved in a horizontal plane due to the shorter focus for the ultra-violet radiations. A sheet of uranium glass was supported in an adjustable holder and used to explore and focus the ultra-violet. The ultra-violet lines showed up sharply and distinctly on this plate and could be located accurately. Similarly supported on a stand was a small (13 mm.) total reflection prism of quartz which, when placed in the converging light, served to reflect it downward to a focus on a small, adjustable, horizontal table on which the cultures were placed for exposure. The entire apparatus, with the exception of the lamp, was enclosed in a light-proof case provided with a head-cloth to make inspection and adjustment possible during runs.

After the apparatus was rigidly adjusted to minimum deviation of the sodium line, the spectrum of the mercury arc was explored with the uranium glass and compared with a photograph of the arc spectrum made in the Cooper-Hewitt laboratories. This photograph was marked in wave-lengths. All of the lines in the photograph were located and, in addition, 4 lines in the neighborhood of 1900–2000 not visible on the photograph.

The positions and wave-lengths of all of the lines were accurately noted on the top of the horizontal table as they were thrown down in succession by moving the reflecting prism. The iron arc spectrum was next calibrated by direct comparison with the mercury spectrum. The reflecting prism was placed, as is usual in such comparisons, so that it covered half of the slit and both spectra were thus thrown edge to edge on the uranium screen. In this way the wave lengths of eight lines in the ultra-violet of

TABLE NO. 1.

Material.	Thickness.	Limits.
Glass—		
plate—greenish	3.15 mm.	Cuts clean to 334—dims 334.
plate—greenish	2.0 mm.	Cuts clean to 334—
plate white	1.96 mm.	Dims 291, 303 and 313 a little.
	3.99 mm.	Dims 313 a little, shows 302 very faint.
cover glass	.15 mm.	Dims 302 and 291, no effect on 313.
cover glass	.12 mm.	Extinguishes all beyond 253.
		Cuts 265 and 253 to about $\frac{1}{5}$. Dims 291.
watch crystal	1.85 mm.	Nearly extinguishes 291.
		Dims 303 and 313.
Quartz—		
plates	3.0 cm.	No effect.
Distilled water		
in glass cells		
quartz ends	1 cm.	No effect.
	1.5 cm.	No effect.
Celluloid—		
transparent		
yellowish	1.63 mm.	Cuts to 334. 334 very dim. 365 dim.
Agar-agar—		
solid plate on quartz	1.5 mm.	Cuts sharp to 290—no effect above.
Grease—(beeswax)	.9 mm.	Cuts 236—dims 253 and 313 a little.
films on quartz		Transmits 275.
on glass (thin white)		Transmits 313.

the iron arc were accurately determined and others were subsequently located by comparison with the excellent chart of the iron spectrum prepared by Buisson and Fabry.

At this stage the extent and intensity of the ultra-violet portions of the mercury and iron arcs were compared directly and it was unmistakable that, at ampereages above twelve, the iron arc gave shorter ultra-violet radiations (running down to 1850, the limit set by the absorption of the quartz) than does the 110-volt mercury arc and, in spite of the closely set

lines nearly uniformly distributed, an intensity at all points comparable with that of the isolated lines of the mercury arc. The iron arc ought, therefore, to be, excepting for its unsteadiness, better suited to work in the ultra-violet than is the quartz mercury lamp. As might be expected, the intensity of the ultra-violet radiations from the iron arc increases with the ampereage used. The relative intensities were in all cases judged by the energy of fluorescence on the uranium glass.

The transmission limits of certain thicknesses of glass, of layers of water and of other substances were measured in order that plates of these materials might be used as screens to cut off the shorter wave lengths when this was desirable. The transmission was determined by the use of the uranium glass and the mercury arc. The results of the tests are shown in Table No. 1.

The purpose was to start with certain typical bacteria both pathogenic and non-pathogenic forms. The ones selected were B. prodigeosus, B. pseudomonas pyocyaneus, B. coli communis, and B. typhosus. In most of the work following cultures were made of these types in nutrient and non-nutrient water and exposed in definite wave-lengths of radiation for a certain known period. The exposed emulsions were then sown into agar plates in Petri dishes and incubated, with control cultures, for 24 hours at 37.5 degrees centigrade. Examination with a hand lens over a counting plate made possible the determination of the effect of the radiation. Some determinations of the effects of the radiations on motility were made using hanging drop preparations of the liquid cultures and (as noted subsequently) a number of series were run through with surface colonies made by direct inoculation of agar plates with a platinum needle.

In order to check the work of others done with the full radiation of the sources, the lamps were set up with proper diaphragms and supports and experiments run through as noted in Table No. 2.

These plates were incubated for 24 hours and the presence of the living bacteria demonstrated by the development of the green pigment. The tests, as actually made, were in the reverse order of the numbers here given. The conclusion is unavoidable—that pyocyaneus, when in surface colonies on agar, is not killed by the full radiation of the mercury lamp even at very short distances and long times. The glass screen used on cultures 1 and 13 cut off all radiation shorter than 365 units. (See Table No. 3.)

In making these tests the arcs were turned vertically and the emulsions exposed in quartz-bottomed cells. An electric fan placed on a level with the cell, at one side, was an essential part of this arrangement. The fan kept the cell cool and, in the use of the iron arc, prevented the condensation of the smoke of the arc on the quartz plate. One cubic centimeter from each sample was sown into the agar plates and, where any growth developed, the colonies were counted. The controls developed above 50,000 bacteria per cc.

TABLE NO. 2.

B. Pseudomonas Pyocyaneus—Fresh Surface Cultures on Agar.

Full Radiation of the Mercury Arc.

No.	Distance.	Time.	Results.	Remarks.
1	5 cm.	1 hr.	+	Under glass—water-cooled
2	5 cm.	1 hr.	+	Under quartz—water-cooled
3	8 cm.	1 min.	0	Under quartz—plate very hot
4	8 cm.	1 min.	+	Under quartz
5	8 cm.	15 min.	+	Under quartz—water-cooled
6	10 cm.	1 min.	+	Under quartz
7	10 cm.	1 min.	+	
8	22 cm.	1 min.	+	Under quartz
9	22 cm.	5 min.	+	Under quartz
10	22 cm.	5 min.	+	Under quartz
11	22 cm.	5 min.	+	Under quartz
12	22 cm.	5 min.	+	Under quartz
13	22 cm.	7 min.	+	Under glass
14	22 cm.	7 min.	+	Under quartz
Controls				

+ = normal growth. 0 = no growth.

TABLE NO. 3.

Pyocyaneus in Water. Full Radiation.

A.—Mercury lamp.

No.	Distance.	Time.	Results.	Remarks.
1	8 cm.	1 min.	0	3 cc. of emulsion
2	8 cm.	1 min.	0	1 cc. of emulsion
3	Control		+	

B.—Iron arc. 12 amperes.

1	8 cm.	30 min.	0	3 cc. emulsion
2	8 cm.	20 min.	0	3 cc. emulsion
3	Control		+	
4	8 cm.	1 min.	0	3 cc. emulsion

These results show that pyocyaneus, when in emulsion in water, is killed with ease and certainty by very short exposures—on agar it is not at all affected. This is remarkable.

The following tests were made with B. typhosus.

TABLE NO. 4.

AGAR PLATES INOCULATED WITH TYPHOSUS AND EXPOSED TO THE FULL RADIATION OF THE MERCURY LAMP.

No.	Distance.	Time.	Results.	Remarks.
1	5 cm.	1 min.	+	Under glass—3.15 mm.
2	5 cm.	1 min.	Inhibited	Under quartz
3	10 cm.	1 min.	Inhibited	
4	10 cm.	5 min.	Inhibited	
5	10 cm.	10 min.	0	Water-cooled under quartz
6	10 cm.	10 min.	+	Water-cooled under glass 3.15 mm.
7	Control		+	
8	Control	10 min.	+	Water-cooled under glass .13 mm.

The greater susceptibility of this bacterium (as compared with pyocyaneus) is here evident. The growth is seriously interfered with even for exposures so short as one minute and, in spite of the heavy inoculation with bacterial scum, none survive after 10 minutes at 10 cm. It is to be observed that the destructive effects are completely eliminated by a screen of glass .13 mm. thick which cuts out radiations shorter than 250 and impedes all shorter than 313. Unless care be taken in work of this kind destruction of the bacteria is likely to result from overheating—a temperature of 60 degrees centigrade being fatal. As above noted, the exposed plates were water-cooled and thermometers were supported over them to make certain that the temperature never rose above 40 degrees.

An emulsion was now made of typhosus in normal salt solution. Portions of this emulsion were treated in glass cells under quartz covers to the full radiation of the mercury lamp and were then sown into agar plates and incubated. The results are tabulated below. The numbers given show the bacteria alive per cc. after exposure.

Analysis of this set of results justifies the conclusion that at a distance of 5 cm. exposures of longer than 30 seconds will kill all of the typhoid bacteria in emulsion in water if the layer does not exceed .5 cm. in depth. It is to be observed that in deeper layers the action is less effective and that

TABLE NO. 5.

TYPHOSUS IN NORMAL SALT SOLUTION—FULL RADIATION OF MERCURY ARC.

Nos.	Distance.	Time.	Depth— 5 mm.	1 cm.	1 mm.	Under Glass 5 mm.
1–2–3	5 cm.	5 sec.	23	2500		500
4–5–6	5 cm.	10 sec.	15	90		250
7–8–9	5 cm.	30 sec.	0	22		720
10–11–12	10 cm.	30 sec.	21	20	210	
13–14–15	10 cm.	1 min.	2	28	2	
16–17–18	10 cm.	3 min.	12	4	contaminated	

4 controls—21 cc.—too many to count.
2.1 cc.—30,000 and 27,000 per cc.

through glass (watch crystal transmitting nothing below 290) the development of this particular bacterium is inhibited. This last result is not consistent with other tests. The water worked with contained about 30,000 bacteria per cc. which is a number considerably higher than would ordinarily occur in contaminated drinking water. If the results in the last tabulation are expressed in percents they seem more striking.

Bacillus coli communis was subjected to the following tests under full radiation (mercury arc).

TABLE NO. 6.

No. 1. Freshly inoculated agar plate 12 cm. from the lamp for 15 min. (under quartz). Growth—normal.

No. 2. Emulsion in distilled water—3 mm. deep—exposed at 12 cm. for 8 min. Agar plate inoculated from the emulsion by use of a platinum needle. No growth.

No. 3. Like No. 2—for 1 min. No growth.

The single surface colony determination (1) can hardly be depended on as it stands alone. Here, however, as elsewhere the bactericidal action of the radiation is seen to be much more rapid and effective on bacteria in water than on surface colonies in any type.

Emulsions were now made of coli in distilled water, in normal salt solution and in ordinary tap water and were exposed in glass cells under quartz to the full radiation of the mercury arc. One cc. from each sample was sown into agar and incubated as in the earlier work. The results follow:

TABLE NO. 7.

No.	Distance.	Time.	Depth.	Result.	Remarks.
	5 cm.	1 min.	5 mm.	0	In distilled water
2	5 cm.	1 min.	2 mm.	0	In salt water
3	5 cm.	1 min.	5 mm.	0	In tap water
4	5 cm.	5 min.	5 mm.	0	In distilled water
5	10 cm.	1 min.	5 min.	3/cc.	In distilled water
6	10 cm.	1¼ min.	5 mm.	+	In salt water
7	10 cm.	5 min.	5 mm.	1/cc.	In distilled water
8	10 cm.	5 min.	5 mm.	0	In salt water
9	10 cm.	5 min.	5 mm.	0	In tap water
10	10 cm.	5 min.	2½ mm.		Lost
11	10 cm.	15 min.	5 mm.	0	In distilled water

Two controls—1200/cc.—normal.

It is evident from this tabulation that coli communis is very sensitive to the action of this light. Exposures of one minute at five centimeters destroy them completely. The action is unaffected by the small quantities of dissolved and suspended matter in the tap water.

A series of parallel tests were run with this organism using the iron arc. The emulsions were placed in quartz bottomed brass cells which, from their construction, were very hard to sterilize so that several of the emulsions were contaminated as noted. (See Table No. 8.)

The comparisons of the mercury and iron spectra referred to earlier in this paper indicated that the iron arc should be at least as effective as the mercury arc in treating bacteria. The results in this last table together with those previously stated for pyocyaneus, show that they are, in fact, of the same order of effectiveness.

The conclusion of this work up to this point is that bacteria of the coli type (including typhosus) are, when in emulsion in water, readily killed by short exposures to lights containing amongst others radiations shorter than 2,500 units in length. Pyogenic bacteria—at any rate pyocyaneus—are somewhat more resistant. This is practically the same conclusion as that reached by Henri. We will now pass on to a study of the effect on these bacteria of isolated ultra-violet waves.

The reflecting prism of the quartz spectroscope described early in this paper was adjusted to throw down a certain line of the mercury arc or a certain narrow group of lines of the iron spectrum. In this way an illuminated area, 2 cm. by 2 or 3 mm., was obtained on a certain mark on the horizontal table. The colony or emulsion was placed over this mark and properly screened from stray light by means of a slotted diaphragm.

TABLE NO. 8.

COLI IN EMULSION—FULL RADIATION OF THE IRON ARC.

No.	Distance.	Time.	Depth.	Result.	Remarks.
1	8 cm.	1 min.	4 mm.	contaminated	
2	8 cm.	5 min.	4 mm.	1/cc.	
3	8 cm.	15 min.	4 mm.	contaminated	
4	8 cm.	30 min.	4 mm.	1/cc.	
5	8 cm.	5 min.	2 mm.	0	
6	8 cm.	1 min.	2 mm.	0	
7	25 cm.	10 min.	4 mm.	contaminated	

Two controls—normal—about 30,000 per cc.

The first experiments were made with surface colonies of pyocyaneus on agar-agar. A pencil mark, 1 cm. or 1.5 cm. in length, was made on the bottom of the dish near the center. The plate was then inoculated from a culture tube by drawing a platinum needle along the mark. It had been found (see Table 2) that the full radiation at short distance and long time had no effect whatever on pyocyaneus on agar so that it is not surprising to find the analyzed radiation equally ineffective. Table 9 is a condensed report of the experiments.

Similar experiments on pyocyaneus on agar, using the mercury arc, gave the results shown in Table 10.

In using these isolated lines a distance was taken such that the radiation certainly completely covered the area of inoculation. These tables show that isolated ultra-violet radiation of the intensity here used, as short as 240 $\mu\mu$, will not kill pyocyaneus in surface colonies on agar. It must be remembered, however, that the full radiation did not affect surface colonies of this organism. (See Table 2.) The same organism in emulsion in water was readily killed by full radiation. (See Table 3.) Because of the suspicion that some of the bacteria were protected by a film of agar (the high absorbing power of which has been stated), no further experiments were made using this method.

A glass plate was cut and a slot ground in it with an opening 2 mm. by 10 mm. and 5 mm. deep. This plate was sterilized by boiling in distilled water for 40 minutes, the slot filled with an emulsion of the bacteria by means of a sterile bulb pipette, the slot then covered with a thin, sterile quartz cover and exposed on the horizontal table as before. The emulsion was then sown into agar plates and incubated. In this way the effect of the ultra-violet radiation of a limited range of wave-lengths (2 $\mu\mu$ approxi-

TABLE NO. 9.

PYOCYANEUS ON AGAR—DISPERSED RADIATION OF THE IRON ARC.

Region	1	2	3	4	5	6	
Wave-length	400	370	320	280	260	240	in $\mu\mu$

No.	Region.	Time.	Results.	Remarks.
1	1	15 min.	+	Lighter green than controls.
2	2	15 min.	+	Lighter green than controls.
3	3	15 min.	+	Lighter green than controls.
4	4	15 min.	+	Lighter green than controls.
5	5	15 min.	+	Lighter green than controls.
6	6	15 min.	+	Lighter green than controls.
7	1	30 min.	+	
8	2	30 min.	+	
9	3	20 min.	+	
10	4	15 min.	+	
11	5	15 min.	+	
12	6	10 min.	+	
13	6	16 min.	+	
14	6	30 min.	+	
15	6	20 min.	+	
16	5	20 min.	+	
17	5	60 min.	+	Pale.
18	4	15 min.	+	
19	4	30 min.	+	
20	4	45 min.	+	
21	3	2 hr. 23 min.	+	

Controls—all normal.

mately) was determined with all other radiation excluded. It is to be noted that, in spite of the slight apparent intensity of the radiation here used compared to the full radiation of the source, we have, nevertheless, practically all of the radiation of that particular wave-length contained in the full radiation (or such of it as gets through the collimator slit)—for quartz and air in layers of the thickness here used are said to absorb waves of lengths above 200 $\mu\mu$ very little. Further, the volumes of the emulsion and the shape of the container were here so altered, in proportion to the solid angle subtended, that the total flux through the slit gave approximately the same total radiation per cubic mil'imeter of emulsion as was applied in the use of the full radiation. On account of the collimation and

TABLE NO. 10.

PYOCYANEUS ON AGAR—DISPERSED RADIATION OF MERCURY ARC.

No.	Line.	Time.	Results.	Remarks.
1	313 $\mu\mu$	10 min.	+	
2	313	10 min.	+	
3	295	10 min.	+	
4	253	5 min.	+	Less green.
5	253	10 min.	+	
6	253	15 min.	+	Less green.
7	253	20 min.	+	
8	253	30 min.	+	
9	236	5 min.	+	
10	236	10 min.	+	
11	236	15 min.	+	

Controls—all normal.

focusing of the beam there was no decrease in the intensity due to the inverse square law and the conditions, as far as these lengths of ultra-violet radiation were concerned, were practically the same as if the emulsions were in the full radiation of the source at a distance of 25 centimeters, that is, the distance from the source to the collimating lens. The difference between the full radiation at the shorter distance and the dispersed radiation at the longer is threefold. In the first place, the full radiation may contain certain very short waves (under 185 $\mu\mu$) which are absorbed by air and by thin quartz. Shuman found, however, that one millimeter of air absorbed completely all radiations under 170 $\mu\mu$ so that these waves are obviously an unimportant factor. In the second place, the ultra-violet in the full radiation is associated with longer waves of greater penetration which may render the organisms more susceptible. In the third place the intensity of the ultra-violet in the dispersed radiation is diminished through reflection from the prism faces and through absorption in the quartz prisms and lenses. The effects of these differenees will be studied in full later. The results of the experiments made by the method outlined above follow.

Study of these results especially (2, 3, 6 and 7) and comparison with the results obtained with the full radiation justified the conclusion that the isolated ultra-violet as here used is, for some reason, much less destructive of bacteria than is the full radiation. As this result was entirely unexpected a careful study was made of the differences in the two methods of irradiation. In the use of the isolated ultra-violet we have as above stated: (1)

TABLE NO. 11.

B. Coli in Slot Slide. + = Growth Normal.

No.	Line.	Time.	Results.	Remarks.
1	280 $\mu\mu$	2 hr.	+	Iron arc.
2	253	2½ hr.	+	Iron arc.
3	253	2 hr.	+	Iron arc.
4	265	2 hr.	+	Iron arc.
5	280	1 hr.	+	Iron arc.
6	250	¾ hr.	+	Mercury arc.
7	236	1 hr.	+	Mercury arc.

Controls—all normal.

a greater distance from source to emulsion. This affects (a) the direct heating, (b) the intensity by inverse square effect, (c) the intensity through air absorption. (2) The radiation is transmitted through approximately four centimeters of quartz and, further, is weakened through two reflections from the prism faces. (3) The ultra-violet radiations are not associated with any longer waves of greater penetration.

In analyzing these differences it is to be observed that the emulsions were cooled by water or by fan and the temperatures kept low in both methods of exposing. Consequently no effect in either case can properly be ascribed to direct heating. Further, as stated on page 986, the collimation of the light prevented any decrease in intensity due to the inverse square law beyond the collimating lens. In these experiments the effective distance from the source was 25 centimeters—a distance at which the full radiation kills in fifteen minutes or less. In order to settle these points more definitely, and also to study the effect of air absorption, the following experiments with full radiation and long air path were made. In these experiments the distances used (See 1 and 4) are greater than the total path from source to emulsion in the spectroscope. The time required to destroy the bacteria is relatively greater than for short distances but destruction is complete in a maximum of 45 minutes.

In regard to the effect of absorption in the quartz parts of the apparatus and the loss through reflection at the prism faces nothing very definite can be said *a priori*. The effect of the absorption of four centimeters of quartz on the shorter waves might be marked. As for reflection, the reflecting power of quartz in the ultra-violet has not been adequately investigated. Working near the absorption region for ultra-violet as we

TABLE NO. 12.

FULL RADIATION—THROUGH 3 MM. IN GLASS CELLS. (B. TYPHOSUS.)

No.	Distance.	Time.	Results.	Remarks.
1	55 cm.	45 min.	0 (1/cc.)	Mercury arc.
2	55 cm.	15 min.	Retarded	Slightly. Hg. arc.
3	25 cm.	20 min.	Lost	Slightly. Hg. arc.
4	55 cm.	35 min.	0 (1/cc.)	Iron arc.
5	25 cm.	10 min.	contaminated	Iron arc.

Controls—all normal—about 35,000 per cc.

are here we must, however, anticipate a large loss due to reflection at the oblique surfaces. An approximate calculation gave the loss at each surface to be of the order of 15 per cent. Special experiments were therefore necessary to determine definitely the effect of these factors on the destructive action of the full radiation.

EXPERIMENT NO. A.

The apparatus was set up as shown schematically in Fig. 1. The emulsion was contained in a small porcelain crucible (4 mm. diameter at the bottom) and was exposed to the full radiation of the mercury lamp at a distance of 20 mm. The radiation passed through 4.3 cm. of quartz obtained by superposing eleven quartz plates of various thicknesses. A

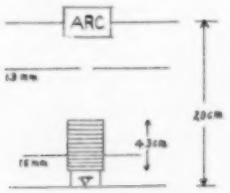

FIG. I

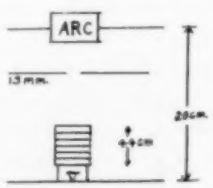

FIG. II

diaphragm under the arc cut the source of light to a circle of 13 mm. diameter. A second diaphragm with an opening 15 mm. in diameter was introduced into the pile of plates. The exposure was for 20 minutes and the destruction was complete. The control contained 30,000 typhosus per cc.—the exposed emulsion 0. Here we have 22 normal reflecting surfaces in the light path.

Experiment No. B.

This experiment was designed to check Experiment No. A. A single diaphragm (13 mm. opening) was placed as shown in Fig. 2 and the quartz path was made up of 6 plates aggregating 4.41 cm. Here we have, of course, twelve reflecting surfaces. The exposure was for 20 minutes as before. The destruction was practically complete—eight bacteria per cc. surviving. The control showed 35,000 per cc.

Experiment No. C.

In this experiment the effect produced by oblique reflections was investigated. Two quartz plates were set in the light path at angles equal to those offered by the prism faces in the spectroscope. In addition quartz plates were used giving a total quartz path of 4.5 cm. and an air path of 20 cm. (Fig. 3) The exposure was for 30 minutes. Destruction was complete—. the control showing 35,000 per cc.—the exposed emulsion 0.

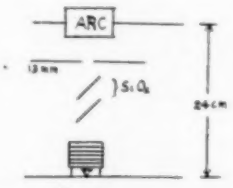

Fig III

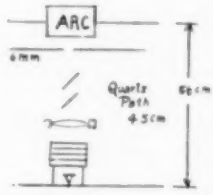

Fig IV

Experiment No. D.

The effort was made here to reproduce the conditions in the spectroscope in regard to air-path, quartz-path, reflections and total irradiation. The apparatus was set up as shown in Fig. 4. The diaphragm opening was reduced to 6 mm. diameter. In the light-path were two oblique plates, one biconvex lens and four horizontal plates. The quartz path was 4.5 cm. —the air path 51.5 cm. We have here a longer air path than in the spectroscope—a longer quartz path, as many oblique reflections and, in addition, eight normal reflecting surfaces. The area over which the light that came through the diaphragm opening was diffused was measured and the ratio to the area of the crucible taken. This showed that 1-180 of the light that came through the hole fell on the emulsion. The area of the slit of the spectroscope was also measured and the area of diffusion in the plane of the collimating lens. This showed that 1-12 of the light that came through the slit fell on the lens. Calculations based on this data show that approximately twice as much ultra-violet radiation must fall, in any given time, on an emulsion on the table of the spectroscope as fell on the emulsion in the crucible in this last experiment. The exposure was

for one hour and the destruction was complete. The control developed 30,000 typhosus per cc.—the exposed emulsion 0 per cc.

These experimental results seem to prove conclusively that the destructive action of the light ought not to be in any way diminished in passing through a spectroscopic apparatus of the type and size of the one employed in this investigation.

A final series of experiments was now made with isolated radiations. The mercury arc was used as before. On account of the ease and certainty of sterilization the small porcelain crucible was used in place of the slotted glass slide. Four or five drops of the emulsions were used and controls made up with the same amounts. The distances were so taken that the lines used, as located on the fluorescent glass, covered the entire emulsion. In order to make absolutely certain of this point the crucible was rotated in the line during exposure at the rate of one revolution in 45 minutes, by a small clinostat. The adjustments were very carefully made and checked repeatedly during runs. The results are summarized in Table No. 13.

The following facts seem evident from these results. Marked destructive effects can be produced by isolated ultra-violet rays 250 $\mu\mu$ or less provided sufficient time is taken. A three-hour exposure is necessary in order to produce a marked result with $\mu\mu$ 250. The destructive effects increase on moving into the shorter wave-lengths—a one-hour exposure in $\mu\mu$ 220 being equivalent to three hours in $\mu\mu$ 250. However even for these rays ($\mu\mu$ 220—the shortest given by the quartz mercury arc) a five-hour exposure does not accomplish complete destruction.

Comparison of these results with those obtained with the full radiation (Table No. 12, see page 988) forces us to the conclusion that the effectiveness of the mercury arc, and similar sources, in killing bacteria rapidly is due to some extent to the association of radiations of greater wave-length and greater penetrating power with the short ultra-violet. Ordinarily the whole effect is ascribed to the ultra-violet. It was thought possible that the comparative ineffectiveness of the isolated rays might be ascribed to absorption in the water of the emulsions but an experiment made with a quartz cell showed that one linear centimeter of normal salt solution plus coli had no apparent absorptive effect on any of the ultra-violet lines—220 or above. It is possible that the longer radiation may render the organisms more susceptible to the action of the shorter—possibly the cell wall absorbs the isolated short waves thus protecting the enclosed protoplasm but the longer radiations, when present, may, in a sense, carry the shorter waves through the cell wall and thus enable them to act destructively on the protoplasmic contents.

This hypothesis can be checked by subjecting emulsions simultaneously to ultra-violet radiation and to longer wave-lengths from a second source.

TABLE NO. 13.

ISOLATED RADIATION OF THE MERCURY ARC. (B. TYPHOSUS.)

Time.	Wave-length.					
	220 $\mu\mu$.		236 $\mu\mu$.		253 $\mu\mu$.	
1 hour	50,000 cut to 5,000	1 / 10				
2 hours			+ + +	1 / 1	+	1 / 1
3 hours	12,000 cut to 150	1 / 80	21,000 cut to 450	1 / 50	12,000 cut to 1,000	1 / 12
4 hours	21,000 cut to 160	1 / 130				
5 hours	12,000 cut to 60	1 / 200				

Ratio of test to control shown by the fractions.

A few experiments of this kind have been made but the number is not yet sufficient to furnish any definite conclusion. It is obvious also that experiments should be made using the radiations from the three ultra-violet groups recombined for, in the full radiation, these wave lengths act simultaneously.

The results of this work may be summarized as follows. The full radiation of certain sources containing waves below 250 $\mu\mu$ in length, will kill bacteria certainly and rapidly. Isolated ultra-violet of lengths 250–280 $\mu\mu$ will not affect bacteria in one drop of water in a four hour exposure. Isolated ultra-violet as short as 220–225 $\mu\mu$ will kill only after several hours exposure even when the isolated radiation is of the same intensity as that contained in the rapidly destructive full radiation. The destructive power increases rapidly with decrease in wave length. The final conclusion is that the destructive effect of ultra-violet light is in some way dependent on its association with longer radiations.

I wish to acknowledge my indebtedness to Dr. Arthur W. Goodspeed, Director of the Randal Morgan Laboratory of Physics, for assistance in carrying out this work. The examination of the exposed cultures—the counting of the colonies, etc. was done by Mr. Edward Pugh, a special student in Bacteriology, who has been associated with me from the first and whose assistance has been necessary and invaluable.

It is proposed to continue this work along the lines indicated in the paragraph at the top of this page.

The Randal Morgan Laboratory of Physics,
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ANTI-TYPHOID VACCINATION.

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Read before the General Sessions, American Public Health Association, Colorado Springs, September, 1913.

It has long been well known that in certain infectious diseases a single attack protects the individuals from subsequent attacks. In some diseases second attacks are not infrequent, but there is usually a considerable interval between two attacks of any of these diseases, and the inference was that temporary immunity results from each attack. That immunity may result from a comparatively mild attack as well as from a severe one is a matter of common observation and it not infrequently happens that mild attacks are not recognized, which leads to the belief that the immunity is due to inheritance.

The production of immunity by protective inoculations was for a long time limited to a single disease, smallpox, and before the discovery of vaccination by Jenner, inoculations with virus obtained from a smallpox patient were extensively practised, these inoculations giving rise to a mild attack of the disease, followed by immunity which was apparently as complete as that following a more severe attack, contracted in the usual way. This method seems to have been practised by eastern nations long before it was introduced into Europe.

In the infectious disease of cattle, known as pleuro-pneumonia, protective inoculations were successfully made sometime before the demonstration, by Pasteur, of the efficacy of such inoculations in anthrax and chicken cholera in 1880. The natives on the banks of the Zambezi River are said to have caused animals to swallow a certain quantity of the liquid from the pleural cavity of an animal recently dead and thus give them immunity. But the method most extensively employed was that discovered by the Boers in South Africa and consisted in inoculating animals in the tail with serum from the lungs of an animal recently dead. This is also the method most extensively employed in Australia. But it was Pasteur's success in immunizing animals against anthrax that led several investigators to the immunization of laboratory animals against typhoid. As early as 1886 it was found that several small non-fatal doses of typhoid bacilli would protect rabbits against subsequent fatal doses, and in the same year Beumer and Pfeiffer immunized mice with potato cultures of typhoid and, by using small but increasing doses, they were able to give definite protection against a subsequent fatal dose. They suggested the use of sterilized cultures for the immunization of men, but made no investigations themselves. Other investigators made similar reports of work on animals, but as practically nothing was then known of the toxin of the typhoid bacillus, nor of the nature of typhoid immunity, little or nothing came of the work.

In 1892 Wasserman and others showed that it was unnecessary to use living bacilli since killed cultures were equally effective and that the immunizing substance was an integral part of the body of the bacillus. Both filtrates, which had been used to some extent up to that time, were effective only in so far as they contained particles of the bacterial cells, that is, the immunizing material was not the bacillus but a chemical substance or toxin elaborated by the bacillus. All the earlier work on animals was incomplete and unsafe as a guide in the immunization of man, and it was not until 1893 and 1894 that Pfeiffer, working with Wasserman and Kolle discovered the nature of immunity in cholera and typhoid, and elaborated a method of measuring its quantity. The results obtained by tests proved conclusively in both animals and man the possibility of producing a high degree of immunity against typhoid by the use of killed cultures, and so far as is known at present there are the same anti-bodies produced as the result of inoculation as are produced during clinical typhoid. The quantity of agglutinins, lysins, and opsonins seems to be greater after vaccination than after typhoid, and it is, therefore, reasonable to expect that the immunity conferred by vaccination will last for a considerable period. This is a question that can only be answered by statistics and it may be some years before it can be definitely settled. It is assuredly two and a half years, probably longer.

At about the same time as the work of Pfeiffer and Kolle in Germany, Sir A. E. Wright of the Medical Corps, British Army, began the inoculation of men in England, and in 1908 introduced it into the British Army. During the Boer war it was used upon Wright's recommendation and, although no statistics were kept, Wright considered that the disease was reduced one-half and its mortality even more. At the close of the war, however, a lack of agreement as to the value of anti-typhoid vaccination led to a suspension of its use in the army and several commissions were appointed to study the problem with the result that the procedure has been reintroduced and the anti-typhoid vaccination campaign actively pursued. The British soldier is now vaccinated on enlistment and revaccinated every thirty months.

The next extensive use of the anti-typhoid vaccine was in the German Colonial Army in South Africa, during the Herero campaign from 1904 to 1907, where the inoculations were undertaken on the advice of Koch. The medical records of this campaign were carefully kept and give us excellent data as to the value of the protection afforded by artificial immunization. These statistics detail the results observed in 7,287 vaccinated and 9,204 unvaccinated subjects among the troops, the prophylactic being voluntary. In all 1,277 cases of typhoid fever were observed. The typhoid cases, among the vaccinated, were 57 per 1,000 and almost double that among the unvaccinated, while the mortality was 6.5 in the vaccinated and

12.8 in the unvaccinated. The uncertain results obtained in the earlier years was, no doubt, due to the difficulty in obtaining a uniformly potent vaccine, and also it should be noted that smaller doses and fewer injections were given then than now. After the Boer war the work practically ceased in England, due to the adverse criticism arising out of the experience there. It can be said, however, that much of the reluctance to continue the vaccination was due to the very exaggerated idea of the negative phase. This idea of a negative phase was advanced by Wright, who believed that the body lost some of its normal protective agencies during the reaction following immediately after the administration of the vaccine, and in the short interval the man was in a condition of increased susceptibility to natural infection, and he advised against the administration of the vaccine to men who were about to enter endemic areas. It is now the opinion of the best-informed writers that such fears are groundless. Both Leischman of the British Army and Major Russell of our own service see no evidence of a negative phase and there is no known objection to giving the prophylactic to those exposed to the disease or during an epidemic.

The anti-typhoid vaccinations in the United States Army have been done under the supervision of Major Russell, where it began in 1909, and during the next two years two thousand men who were vaccinated gave one case of typhoid fever in a man who was inoculated during the incubation period of the fever. On the other hand, there were 150 cases in 65,000 non-vaccinated men. During the spring and summer of 1911 the United States Government mobilized a maneuver force of about 15,000 soldiers in Texas. These were all vaccinated against typhoid and, in the months during which the maneuvers lasted, only two cases of typhoid developed in the camp. One case was in an unvaccinated civilian teamster, and the other was in an enlisted man of the hospital corps who ran a short and attenuated course of fever. During the same period there were 241 cases of typhoid reported in the nearby cities of Galveston and San Antonio, which places the troops had large freedom in visiting. The War Department was so well pleased with the results in Texas that in June, 1911, an order was issued requiring that all men on enlistment receive the anti-typhoid inoculation. At the close of 1911, Ex-President Taft, in responding to an inquiry of the *New York Times* made of a number of famous personages of what they considered the five most notable achievements of the year just past, gave as the second of his answers: "The demonstration of the complete success of the prophylactic in typhoid fever, as shown by the fact that in the mobilization of 15,000 troops in Texas for three months, there was only one case of typhoid."

Our experience with the typhoid prophylactic in Connecticut began in the fall of 1911 when an epidemic of typhoid fever broke out in the borough of Torrington in September of that year. Torrington is a thriving manu-

facturing town of about 17,000 people. During the epidemic, which was due to an infected water supply, there were 329 reported cases and 35 deaths. The town had no hospital and the nearby cities of Waterbury, Winsted and Hartford gave such help as they could, but could not care for all the cases. The borough had a difficult situation confronting it, which was ably met. A local relief committee was at once organized, $25,000 was raised by popular subscription, and the Parish House of the Episcopal Church was soon equipped as a hospital where 112 patients were treated. Eighty trained nurses were employed by the committee, some in private families, but most of them in the temporary hosp tal. What is important as bearing on the so-called negative phase is the fact that forty-five of these eighty nurses were vaccinated immediate'y they were put to work, the others refusing it. Of the vaccinated nurses not one contracted the fever, while four cases developed among the thirty-five unvaccinated nurses. In all, about four hundred inoculations were made. The cases were all carefully selected and no inoculations were given to persons with a temperature or any indication of ill health. Only one case of fever developed among the vaccinated, which was a man who was taken sick soon after his second inoculation and ran a mild and very short case of typhoid. One physician wrote me that at the outset of the epidemic he inoculated himself, wife and two children, and added, "None of us experienced any ill effect and all had a feeling of safety in the depression and panic that pervaded the community."

The following spring, 1912, Company M, Second Infantry, C. N. G., located at Torrington, sent a request to our adjutant general that they be vaccinated against typhoid before going on the summer maneuvers. This request was referred to me as chief surgeon of the brigade and promptly approved with the recommendation that the same privilege be offered to the other commands. The vaccine was drawn from the War Department at Washington and the inoculations made by the regimental surgeons. About three hundred were thus vaccinated. The offer of immunization was also made to our militia this spring and company commanders requested to bring the matter to the attention of their men. The result was that about six hundred have been immunized this year, so that at the present time we have about one third of our militia vaccinated. The readiness with which the offered vaccination was accepted depended apparently on the influence of the officers. Some companies have their entire membership vaccinated while others have not availed themselves at all of the privilege. The exploiting of anti-typhoid vaccination by the state board of health and others, as well as the vaccination of the guard, has, I think, created some public sentiment in its favor, for physicians tell me that there is a considerable demand for it in private practice.

In the vaccination of our militia we had but one unpleasant occurrence, which was that one case of typhoid occurred in a vaccinated man after his

second inoculation. The story was spread abroad that this was the result of the inoculation. As such a report would prevent us from doing much more immunizing among our militia men, if not authoritatively contradicted, we asked the army authorities at Washington to send one of their medical officers to investigate this case. Major Russell was promptly detailed and came at once to Connecticut. In his report on this case he states "that the blood serum gave a negative agglutination reaction against both kinds of para-typhoid bacilli and that the case, so far as he could judge at that time (during convalescence), was a mild case of typhoid. He further states that there is nothing astonishing in the occasional occurrence of a case of typhoid fever following the administration of the typhoid prophylactic. There have been, up to the present time, in the army, beginning with 1909, a total of twenty-seven cases with one death among the vaccinated. No vaccination has ever yet been devised which gives absolute protection and it is unlikely that we shall ever have such an agent. Vaccination against smallpox is universally conceded to be the most successful vaccination used upon human beings up to the present time, yet everybody knows that the protection given by that vaccine is not absolute. A comparison of the results obtained by vaccination against smallpox and immunization against typhoid fever shows that the latter gives results fully as good as the protection against smallpox. Neither gives absolute protection and some cases are bound to occur each year. It is probable that in this case the typhoid prophylactic diminished the severity of the attack." The vaccine used was from a consignment employed in about 500 other vaccinations, and the city of Waterbury, where the case occurred, is not at any time free from typhoid, but had in 1912 a death-rate of about 19 per 100,000, while that for the whole state is 11.3 per 100,000 of population.

The typhoid vaccines are prepared in a number of different ways; that used in our army service is prepaerd as stated by Major Russell from a single strain of the bacillus which has been for many years under cultivation, and has practically lost its virulence, these non-virulent bacilli better stimulating the formation in the blood of anti-bodies and produce a less severe reaction in the individual. The bacillus grow luxuriantly on agar. The cultures are incubated eighteen hours, carefully scrutinized for contaminations and then washed off in salt solution. The emulsion is kept over a water bath for one hour at a temperature of 55° to 56° C. in order to kill the bacilli and is standardized by counting the bacilli in an unkilled sample. After cooling, $\frac{1}{4}$ per cent. of trecresol is added as an antiseptic and animal tests are made for living typhoid bacteria or contaminating organisms.

The vaccination is given hypodermically in three doses, each ten days apart, the entire course thus requiring twenty days. The first dose consists of $\frac{1}{2}$ cc., or $7\frac{1}{2}$ minims containing 500,000,000 bacteria, while the

second and third doses are twice as large, containing 1,000,000,000 bacteria each. The inoculations are made under the skin, not into the muscles, and the site usually chosen is the arm at the insertion of the deltoid. The arm should be cleaned as for any other operation and the hypodermic needle sterilized. The army uses, as an antiseptic, equal parts of tincture of iodine and alcohol with which the skin is painted before and after the hypodermic injection.

The most suitable time for administration is about 4 o'clock in the afternoon, as the greater part of the reaction is then over before morning. As already stated no applicant should be inoculated who is not perfectly healthy and free from fever at the time.

The reaction from the inoculations are two—a moderate local swelling and slight fever. These are of short duration and less severe than the vaccination against smallpox. The entire reaction is usually over in forty-eight hours and many persons suffer no discomfort whatever. The usual history following the inoculation is a slight chill and rise of temperature 99 to 100° with indefinite aches in the back and limbs for about twelve hours, and local swelling and soreness at the site of the inoculation. Some have no reaction whatever, and a few individuals are indisposed for two or three days, the more severe symptoms being high fever, headache, nausea and vomiting. Children, as a rule, react less than adults. Women and children should receive doses according to the body weight, taking 150 pounds as the unit. It is believed that increased resistance begins immediate'y after the first dose, although the degree of immunity is not very high until after the lapse of ten days. The Widal reaction is always positive after typhoid inoculation, appearing within ten days after the first dose and remains positive for six months.

The various commissions which have been appointed in this country and abroad to report on the status of this prophylactic measure have uniformly reported that it is useful, without danger and affords a simple method of diminishing the frequency of typhoid fever. For soldiers in camps, physicians, nurses, travelers, and persons living in endemic territory, it offers a simple means of protection. In civil practice its value has been most noticeable in our hospitals. One of the physicians connected with our homeopathic hospital stated to me recently that for years, to their chagrin and humiliation, and in spite of everything they could do, there had not been a year in which some of the nurses had not contracted typhoid fever in their work, but during the past three years in which the nurses had been vaccinated not a case had developed among them.

It is not be to be expected, however, that typhoid vaccination will ever be used as is smallpox vaccination and depended upon for the eradication of typhoid, nor should it be. For that purpose we must continue to depend on and strive for pure water, pure food, proper sewage disposal and other hygienic measures.

AN EXPERIMENTAL STUDY OF THE RELATIVE EFFICIENCIES OF CERTAIN FERMENTATION TUBES.

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An examination of the literature relative to the use of fermentation tubes in recognizing *B. coli* and other gas-formers in routine examination of pathological material, water, food, etc., reveals the fact that there is considerable diversity of opinion, first as to the reliability and constancy of gas determinations made with these tubes; and second, as to the *relative* accuracy of the different forms.

Some investigators have apparently attached great weight to the data obtained through the use of the Smith tube and the Durham tube. For example, Penfold* in his work on the modification of the *bacillus coli communis* by its cultivation on monochloracetic acid media used the Durham tube in his tests of gas production and formulated new and most important conclusions from the data so obtained. This investigator has seemingly placed great confidence in the use of this tube for making the gas test for diagnostic purposes. On the other hand, there are a large number of workers who use these tubes in making only the so-called "presumptive tests"; and insist on confirmatory tests to establish the data so obtained.

It may be pointed out in this connection that the originator of the Smith tube recognized its limitations. Again, Clark† in an excellent survey of the problem, states that "the unreliability and general inconstancy of determinations made with the Durham tube or Smith tube is, or should be, universally recognized."

Probably the chief fault of both types of tubes is the absorption of large quantities of carbon-dioxide by the medium. Keyes,‡ who was one of the first to recognize the inaccuracies of the Smith tube, devised a method for cultivating the gas-forming organisms *in vacuo*, and then drawing out the gas over mercury for analysis by more accurate methods.

With the evidence at hand it would seem, therefore, that there is very little doubt as to the unreliability of gas determinations made by the methods in common use, but as Clark points out in his criticism of one investigator's work while making a plea for greater care in the analytical procedures of bacteriological chemistry, "unfortunately (he) is not alone

* Penfold, W. J., *Jour. of Hygiene*, **2**, 487 (1911); *Proc. Royal Soc. Med.*, Path. Sect., **4**, pt. 3, 97 (1910-11).

† Clark, W. M., *Science*, **38**, 669 (1913).

‡ Keyes, *Jour. Med. Research*, **21**, 69 (1909).

in the false confidence he has placed in the reliability of the Smith and Durham tube methods of bacterial gas determinations. These instruments, which are useful only in the routine laboratory, are still being widely used in elaborate researches; and the time, therefore, seems ripe to emphasize the errors to which their use may lead, and to plead for greater accuracy in this important test of bacteriological chemistry.

The author of the paper to which reference has just been made makes the further statement, however, which is of particular interest to the authors of this paper, namely, that "the Durham tube while useful as a preliminary qualitative test for gas, is otherwise worthless. It is more inaccurate than the Smith tube . . . . ." This statement regarding the relative accuracy of the two forms of tubes would probably be challenged by a great many workers. The fact that both forms of fermentation tubes are recommended in the literature and are in general use indicates that there is a division of opinion as to which is the more reliable piece of apparatus.

It was this latter phase of the discussion of the problem which first enlisted the attention of the authors and finally led them to the conclusion that while one form might possess peculiar advantages not possessed by the other forms, yet one might be found to be more dependable in *general* than the other.

With regard to the reliability of gas determinations made by the use of the usual forms of fermentation tubes, it should be noted that, whereas this same problem has been considered by others, the angle of attack has been quite different. Some have chosen to regard it from the standpoint of the effect of using various kinds of media. This has led to a great deal of confusion, inasmuch as the media prepared from animal products varies so much in composition that it is practically impossible to produce a medium with known definite properties. To overcome this difficulty some have proposed formulae for synthetic media which would have a well-defined composition and which could be reproduced from time to time. In the production of such an ideal standard medium the authors believe that the problem of identifying certain bacteria by the production of gas in the fermentation tube will be greatly simplified. Others have done a great amount of work on the bacterium itself. To these persons we are indebted for the discovery of the effect of certain media in producing a strain of bacteria with weakened physiological powers, and that the attenuated forms may actually produce so little gas in certain media that the entire amount may be absorbed by the medium itself.

But since various investigators are at present engaged in problems concerning the relations existing between media and bacteria, and that since these reactions will probably be definitely known in the near future, the authors of this article thought it well to determine, if possible, the effi-

ciencies of the tubes employed, using the media which we now have and which are recognized as standards. There is no doubt that too much dependence has been placed on this means of test for gas formers, and that for this reason many serious errors have been made.

The work reported in this paper was carried out under conditions which were intended to give it a practical bearing on the detection of such gas-producers as the *Colon* group. These tests are so frequently made and so much significance is attached to them that the writers felt justified in determining efficiencies on this basis. It is recognized that the ratio of efficiency may be changed greatly when other media are substituted for that used in this work. Such a deduction is easily made when it is recalled that certain attenuated strains of gas-formers produce so little gas in a broth containing dextrose or galactose as to be entirely absorbed by the medium, and that the same strain may produce twice the volume of gas if dulcite or mannite be substituted for the hexose.

But since the work reported here was not intended to take up the matter of bacterial strains, enzymes elaborated, or sugars used, but merely to show the relative efficiencies of the Smith and Durham tubes when used in connection with routine laboratory work and standard media, the data is believed to be of value to all those engaged in such pursuits in estimating the dependence that ought to be placed on the results obtained by the use of these tubes.

For convenience of discussion and in presenting data this paper is divided into four parts; "Method of Procedure," "Tables of Results," "Discussion of Results," and "Summary."

Method of Procedure.

The first problem to be considered was that of the selection of a medium on which to base the work. After a careful study of conditions, especially that of giving the work the greatest practical bearing, standard lactose bile was chosen. In selecting this medium the authors recognized that any attenuated forms of such bacteria as the B. coli would be held inert and that, therefore, no gas would be produced. This objection was overcome, however, by a careful selection of bacteria for inoculation. It was hoped that such procedure would give added significance to the work for those who use fermentation tubes in connection with presumptive tests for B. coli and allied forms in routine work.

Naturally, then, the source of bacteria was of next importance. In order to maintain the object of practicability, water was chosen as the source of supply. This might have offered serious complications but for the fact that in the course of the regular work conducted in these laboratories such samples could be chosen as had previously given positive evidence of the presence of gas-formers in the same medium. Therefore, since both

forms of tubes were used in making the tests of the same samples at varying dilutions, it seems improbable that there should be any serious source of error unless it arise from the dilutions used.

It was decided that the study be conducted with two different dilutions made from the known samples in the standard physiological salt solution. By studying the counts made upon the water used as a source of bacterial supply, it was deemed advisable to use a .1 and a .05 dilution. These dilutions it was hoped would represent fair average tests for the two kinds of tubes.

Ten series of forty tubes each were inoculated and incubated in an electrically heated and regulated incubator at 37½° C. for a total period of seventy-two hours. Each series consisted of ten Smith tubes at each dilution, and ten Durham tubes at each dilution. Readings were made at twelve-hour intervals.

In the series which follow, the figures given represent the number of tubes showing gas at the time indicated at the top of the columns.

TABLES.

Series I.

Hours	12	24	36	48	60	72
Smith tube (con.)	0	4	6	7	7	7
Smith tube (dil.)	0	1	1	1	1	1
Durham tube (con.)	0	2	3	5	6	7
Durham tube (dil.)	0	0	0	0	0	0

Series II.

Hours	12	24	36	48	60	72
Smith tube (con.)	1	1	2	2	2	2
Smith tube (dil.)	0	0	1	1	1	1
Durham tube (con.)	0	2	4	4	4	4
Durham tube (dil.)*	0	0	0	0	0	0

Series III.

Hours	12	24	36	48	60	72
Smith tube (con.)	0	3	7	7	7	8
Smith tube (dil.)	0	1	5	6	6	7
Durham tube (con.)	0	0	5	7	9	10
Durham tube (dil.)	0	1	7	8	8	9

Series IV.

Hours	12	24	36	48	60	72
Smith tube (con.)	0	2	4	5	6	7
Smith tube (dil.)	0	0	2	3	5	5
Durham tube (con.)	0	1	2	5	6	6
Durham tube (dil.)	0	0	1	3	3	5

*(One Durham found broken; regarded as zero.)

SERIES V.

Hours	12	24	36	48	60	72
Smith tube (con.)	0	0	0	0	0	0
Smith tube (dil.)	0	0	0	0	0	0
Durham tube (con.)	0	0	0	0	0	0
Durham tube (dil.)	0	0	0	0	0	0

SERIES VI.

Hours	12	24	36	48	60	72
Smith tube (con.)	0	1	1	2	3	4
Smith tube (dil.)	0	0	1	2	3	3
Durham tube (con.)	0	3	4	4	4	4
Durham tube (dil.)	0	1	3	4	4	4

SERIES VII.

Hours	12	24	36	48	60	72
Smith tube (con.)	0	1	3	4	4	4
Smith tube (dil.)	0	0	1	2	2	3
Durham tube (con.)	0	1	1	3	3	3
Durham tube (dil.)	0	0	0	1	2	3

SERIES VIII.

Hours	12	24	36	48	60	72
Smith tube (con.	0	0	1	2	3	5
Smith tube (dil.)	0	0	0	1	1	1
Durham tube (con.)	0	2	2	2	2	2
Durham tube (dil.)	0	0	0	0	1	2

SERIES IX.

Hours	12	24	36	48	60	72
Smith tube (con.)	3	4	5	5	6	8
Smith tube (dil.)	1	2	5	5	5	5
Durham tube (con.)	1	5	7	9	9	9
Durham tube (dil.)	0	1	4	5	6	6

SERIES X.

Hours	12	24	36	48	60	72
Smith tube (con.)	0	4	5	8	9	9
Smith tube (dil.)	0	0	5	8	9	10
Durham tube (con.)	0	4	5	8	9	9
Durham tube (dil.)	0	1	3	5	8	8

That each series was inoculated with solutions representing different bacterial counts is evident from the figures given. In fact, the work covered such a wide range of concentrations that some series show low numbers during the entire period of incubation while others are relatively high. Series V, which shows no gas in any tube during the entire time of incubation, was inoculated with a dilution from a particular sample which gave gas in both lactose bile and liver broth in the routine work. However, the bacteria count was particularly low in this case.

In all tables discrepancies are apparent, yet the recorded data represents the average result obtained in this laboratory when working with very high dilutions. It was somewhat consoling, however, to learn that others have experienced similar difficulties.

In Table I, which gives the total number of all tubes showing gas at the time indicated, rather remarkable relationships may be traced. When it is recalled that one hundred tubes were run in each case it would seem that there is no great liability of error in taking an average of the results obtained by the described procedure.

TABLE I.

Hours	12	24	36	48	60	72
Smith tube (con.)	4	20	34	42	47	54
Smith tube (dil.)	1	4	21	29	33	36
Durham tube (con.)	1	20	33	47	52	54
Durham tube (dil.)	0	4	18	26	32	37

Since one hundred tubes were inoculated and incubated in each case, this table gives percentage efficiency direct. Attention should be given to the fact that at twenty-four hours the efficiencies of the two types are identical at each dilution. At forty-eight hours, the Durham tube seems to be 5 per cent. more efficient than the Smith tube in concentrated solutions, while with dilute solutions the Smith tube is 3 per cent. more efficient than the Durham tube. These results agree very well with those published by one* or two others working along similar lines.

Discussion of Results.

Perhaps the most obvious result of the work done is the irregularity shown by the figures given in the series. For any particular series there seem to be discrepancies which indicate that neither tube may be depended on for anything like accurate results. A closer analysis, however, reveals facts which partly relieve fermentation tubes of the criticism of being so grossly inaccurate. It was pointed out in a previous statement that the series represent a wide variation of concentration. We may expect, then, that some series will show this fact. Indeed, Series X, is an instance of this, for here we find an efficiency at from 48 to 72 hours' incubation which is fairly satisfactory. In other series we find efficiencies greatly reduced. But this is just what we should expect under certain conditions. If a given sample of water has, for instance, three gas-forming bacteria per cubic centimeter, and from this a one-tenth dilution be made, then the sample used for inoculation will contain one bacterium for approximately each three cubic centimeters. Concordant results from the inoculation of ten tubes with this dilution are scarcely to be expected. Indeed, the prob-

* Brown, W. W., *Amer. Jour. Pub. Health*, 3, No. 7, (1913).

ability of getting one or more bacteria with each cubic centimeter used for inoculating the tubes is very remote. However, as the concentration increases, the probability of inoculating each tube in a series increases until we may obtain such results as are shown in Series X.

In spite of the fact that the series shows such a wide range of efficiencies, it is shown that the ratio of efficiency between the two tubes at different dilutions is fairly constant. We find that at the seventy-two hour reading the efficiencies are identical, but that at forty-eight hours there is a slight difference. But since at great dilution neither tube shows a high percentage of efficiency, it matters little which tube be used.

If, on the other hand, practical value be given significance, the relative efficiencies of these two types of fermentation tubes may take a decided and rather unexpected turn. True efficiency, as far as the laboratory is concerned, should properly be based on two factors: first, the accuracy of results possible, and, second, the cost of use and maintenance. With reference to the first factor there is little preference, but if we stop to consider the second factor there may be shown a higher efficiency for the Durham tube. The higher efficiency for the Durham tube in the second factor results from a lower initial cost, consumption of less media, less space needed for storage, greater economy in incubator space, ease of cleaning, and cheapness of replacement.

Summary.

With the use of lactose bile as a medium, the relative efficiency of the Smith and Durham fermentation tubes has been shown to be as follows:

1. From the standpoint of total efficiency the Durham tube seems to be the superior of the Smith tube.

2. If efficiency is based on the accuracy of results obtainable, at twenty-four hours' incubation there is practically no difference; while at a longer period, the efficiency in concentrated solutions favors the Durham tube; and in dilute solutions the Smith tube is more efficient.

3. Since at high dilutions neither tube is reliable, duplicates, or even triplicates should be used whenever possible.

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THE VIABILITY OF THE TYPHOID BACILLUS IN SOUR CREAM.

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Numerous investigations have shown that typhoid bacilli quickly die in sour milk, butter-milk, and other sour milk preparations. The bacilli are killed by the acid produced as is shown by the fact that lactic and butyric acid have been found to kill typhoid bacilli with varying rapidity, depending on their concentration.

Recently it was claimed that the Department of Health need not insist on pasteurization of sour cream, as the acidity would quickly render it safe, should typhoid bacilli be present. The following experiments were undertaken to determine whether this deduction from the results of previous observers was justified. Not only was the rate of disappearance in naturally souring cream determined, but also in sour cream under conditions where overgrowth by other bacteria was eliminated.

TABLE I.

Sour Cream —27,000,000 bacteria per cc. Typhoid Suspension = { 1–10,000 dilution of 24-hour broth culture used.
Sweet Cream —11,000,000 " " " 30,000 per cc.

1. 50 cc. cream+5 cc. typhoid suspension
2. " " " +1 cc. " "
3. 50 cc. cream+.61 cc. typhoid suspension.
4. " " " +.0001 cc. " "

Mixtures.			4/17.	4/18.	4/19.	4/20.	Total Counts 4/20.	
Sour Cream.	Room Temp.	1.	90%	0.1%	Neg.	Neg.	90,000	Apparent discrepancy between few typhoid added and percentage found is due, partly, to inhibition on special plating media.
		2.	20%	0.1%	"	—		
		3.	3%	0.1%	"	—		
		4.	0.1%	Neg.	"	—		
	Ice Box.	1.	90%	3%	"	Neg.	250,000	Both series, 4/20, gave practically no growth on Conradi, only very fine colonies present.
		2.	30%	0.5%	"	—		
		3.	20%	0.1%	"	—		
		4.	1%	0.1%	"	—		
Sweet Cream.	Room Temp.	1.	98%	8%	Neg.	Neg.	80,000,000	Accurate estimates difficult because of great numbers of non-lactose-fermenting types.
		2.	40%	5%	"	—		
		3.	20%	Neg.	"	—		
		4.	2%	"	"	—		
	Ice Box.	1.	90%	2%	10%	20%	92,000,000	Sweet Cream, Icebox specimen No. 1, was taken out of the icebox April 20, and kept at room temperature. The next day it was negative.
		2.	45%	0.1%	Neg.	—		
		3.	15%	0.1%	"	—		
		4.	0.1%	Neg.	"	—		

By comparing the results with the different samples it seems that the inability to recover typhoid bacilli was due in part to the overgrowth by other bacteria. To determine how far this was a factor, the following tests were made.

A. To fifty cc. of cream were added 7,000,000, typhoid bacilli. The cream was allowed to sour at room temperature and the acidity as well as the percentage of typhoid bacilli determined.

Plated, at once	Typhoid 90%	Reaction 1.02 acid.*
" after 24 hours	" 2%	" 4.7% "
" " 48 "	" 0	" 6.8% "

B. Fifty cc. was allowed to sour over night, heated in the Arnold sterilizer and typhoid bacilli added as above. The heated cream gave no growth when plated on agar.

Plated, at once,	140,000 typhoid bacilli per cc.	Reaction 3.6% acid.
" after 24 hours.	80,000 " " "	" " "
" " 48 "	55,000 " " "	" " "
" " 96 "	4,000 " " " †	" not tested.
" " 120 "	0 " " " ‡	" 7.6% acid.

From these results it is evident there is a reduction in the number of typhoid bacilli when the acidity rises above 3 per cent.

Because of the contamination of the above series the tests on sterilized sour cream were repeated, using two samples of cream at different degrees of acidity. The mixtures were kept at room temperature.

Plated.	*7% Acid.* No. of typhoid per cc.	*5.6% Acid.* No. of typhoid per cc.
At once	375,000	385,000
After 24 hours.	110,000	230,000
" 48 "	7,800	56,000
" 72 "	200	3,000
" 96 "	0	0

To obtain a souring cream, but at the same time to avoid the overgrowth of the typhoid bacilli on the plating medium, cream was inoculated with typhoid bacilli and B. Metchnikovii. The mixture was kept at room temperature and the souring for this reason proceeded very slowly.

* Number of cc. of normal alkali needed to neutralise 100 cc. of cream, phenophthalein being the indicator.
† Contamination, 2,000,000 colonies per cc. in agar. Most of the types do not develop on Conradi.
‡ Total count, 15,000,000.

Days.	0	2	7	8	9	10	11
Reaction.	1.0%	2.2%	5%	—	—	—	10%
No. of Typhoid.	392,000	65,000,000	300,000,000	113,000,000	181,000	2,600	400

Evidently the time required to kill the bacilli is directly proportional to the number of typhoid bacilli present.

Summary. The typhoid bacillus is gradually killed in sour cream by the acids produced, the rate of destruction being proportional to the degree of acidity and the number of typhoid bacilli present. The apparent disappearance of typhoid bacilli in sour cream where the normal flora is present is due in part to the overgrowth of the typhoid bacillus by these bacteria and the difficulty of finding by our present methods the proportionately few typhoid bacilli remaining.

With a moderate contamination, the typhoid bacilli are killed in about four days. With a heavy contamination or where initial multiplication has taken place, a longer time may be required. For this reason a clean cream which soured slowly would be more dangerous if contaminated, as an initial multiplication of the typhoid bacilli would occur and a longer time would be required to destroy the bacilli. Whether under ordinary conditions the overgrowth by the bacteria of the cream is a factor in the death of the typhoid bacilli cannot be determined by our present methods.

ICE CREAM STUDIES IN CINCINNATI.*

CLARENCE BAHLMAN,
Chemist, Cincinnati Department of Health.

The great interest in bacteriological milk examination shown by public health workers during recent years is well known, and the value of such activity needs no demonstration. Statistics prove that the effect of decreasing the bacteriological content of milk results in decreased infantile mortality; and, in view of this fact, it seems surprising that there is such a widespread lack of interest in the study of ice cream.

Ice cream is a product of milk, subject to the same dangers of contamination, to the same spoilage if not properly kept. Dairymen are vigorously prosecuted if their milk is deficient by a few tenths of 1 per cent. in fat or solids or, in some instances, if their bacterial count exceeds 500,000 or 1,000,000. If a few million bacteria in milk indicates filth, improper handling and, consequently, danger to public health, why should ice cream containing tens and hundreds of millions of these same organisms be sold with impunity?

Many states and cities have either definite or suggestive standards of 500,000 bacteria per cubic centimeter for frozen milk products. So far as we know, however, such rulings are not enforced and only a very small percentage of the commercial ice creams could comply with them. Moreover, unless standards for fat are enforced, competition is unfair, and an inferior article, loaded with fillers and poorer in fat than low grade milk, can be sold at the price of a cleaner and more nutritious product.

The first bacteriological ice cream examinations in Cincinnati were made in 1911. During the summer months of 1911 and 1912, bacterial counts were made upon 67 samples, following the standard methods of the American Public Health Association. The results are shown in Table No. 1.

Evidently there is some cause for such enormous numbers, and some remedy must exist which will effect a reduction. As to the cause, high counts in the original cream and milk, unsanitary factories, and careless handling at once suggest themselves.

Repeated inspections of our ice cream plants were made in 1913, sanitary regulations were enforced, many of the poorer plants discontinued business, and others were extensively remodeled.

The advent of the year 1914 found our ice cream plants in a very satisfactory condition. The quality of the cream supply, bacteriologically, had also improved considerably. While we have no routine cream counts to measure such improvement, it is safe to assume that the great decrease from year to year in the bacterial content of our routine milk samples has been accompanied by a proportional improvement in the cream supply.

* Reported before the Milk Commission on National Milk Standards of the New York Milk Committee, April, 1914.

TABLE NO. 1.

Bacteriological Ice Cream Counts—Summers of 1911 and 1912.

Bacteria per cc.	No. of samples.	Per cent.	
Below 100,001	0	0.0	
100,001–250,001	4	6.0	
250,001–500,001	1	1.5	500,000 and below ... 7.5%
500,001–1,000,001	4	6.0	1,000,000 and below.. 13.5%
1,000,001–2,000,001	6	8.9	
2,000,001–5,000,001	4	6.0	5,000,000 and below.. 28.4%
5,000,001–10,000,001	16	23.9	10,000,000 and below. 52.3%
10,000,001–25,000,001	19	28.3	Over 10,000,000..... 47.7%
25,000,001–50,000,001	4	6.0	
50,000,001–100,000,001	3	4.4	
Over 100,000,000	6	9.0	
	67	100.0	

Minimum ..... 200,000 bacteria per cc.
Maximum ..... 400,000,000 bacteria per cc.

Practically all of our retail milk is now pasteurized, as well as a large percentage of the cream used by ice cream manufacturers.

It was natural, then, to expect that ice cream samples taken this year should be of lower bacterial content than earlier samples. Thirty-nine samples of plain vanilla ice creams, representing the products of all factories working at that time, were collected during the first week of March, 1914. The ice creams were said to be from two hours to three days old. The bacteriological results are shown in Table No. 2.

This table indicates that cleanliness and pasteurization have accomplished very satisfactory results. The counts are considerably lower than any that we are able to find in reports and journals on file in our office. It should be borne in mind, however, that this comparatively low bacterial content is also partly due to the cold weather prevailing at the time of sampling. Routine milk examinations indicate that the bacterial content depends greatly upon the temperature, and cream, both raw and pasteurized, will also show the same seasonal variations.

As a result of the above tests and of laboratory experiments outlined below, our Food Inspection Department has issued orders that all cream used in the manufacture of ice cream must be pasteurized. Some time will be required before the equipment necessary to pasteurize the entire

TABLE NO. 2.

Bacteriological Ice Cream Counts, March 1914.

Bacteria per cc.	No. of samples.	Per cent.		
Below 100,001	8	20.5		
100,001–250,001	15	38.5		
250,001–500,001	4	10.2	500,000 and below ...	69.2%
500,001–1,000,001	5	12.8	1,000,000 and below .	82.0%
1,000,001–2,000,001	3	7.6	2,000,000 and below .	89.6%
2,000,001–5,000,001	1	2.6	5,000,000 and below .	92.2%
5,000,001–10,000,001	1	2.6	10,000,000 and below	94.8%
10,000,001–25,000,001	1	2.6	Over 10,000,000.....	5.2%
25,000,001–50,000,001	1	2.6		
Over 50,000,000	0	0.0		
	39	100.0		

Minimum ..... 60,000 bacteria per cc.
Maximum ..... 35,000,000 bacteria per cc.

Presumptive Test for B. Coli, Lactose Bile.

Per cent. of samples positive in 0.1 cc.	53.8
Per cent. of samples positive in 0.01 cc.	25.6
Per cent. of samples positive in 0.001 cc.	15.4
Per cent. of samples positive in 0.0001 cc.	10.3
Per cent. of samples positive in 0.00001 cc.	0.0

cream supply is installed, but the result will undoubtedly be a material reduction in the bacterial flora of the ice cream.

Experimental.

In order to study the effect of various ingredients upon the bacterial content of ice cream, the following laboratory work was undertaken.

Experiment No. 1.

Although gelatin is known to carry large numbers of bacteria, very little data on this subject has been published. Samples of well-known household gelatins and of bulk gelatins obtained from ice cream manufacturers were tested. A one-gram portion (passed through a sterile meat grinder if in large shreds or sheets) was allowed to soak in 100 cc. sterile water for about 30 minutes until the gelatin had plumped up and become translucent. The gelatin was then melted by immersing the container in water

not above 40° C. When completely melted, dilutions were planted into media. The results are shown in Table No. 3.

TABLE NO. 3.

Bacteria Per Gram on Various Commercial Gelatins

Brand.	*Gelatin.* 3 days room temp. 58–68 Fahr.		*Agar.* 48 hours 37.5° C.	B. coli, per gram, lactose bile, 72 hours, 37.5° C.
	Total	Liquefiers		
Cox's	900	*	1,600	*
Knox's	300,000	5,000	35,000	Between 10 and 100
Minute	750,000	*	900,000	Between 1000 and 10,000
Jell-O	3,500	*	5,000	Between 10 and 100
Clarkson's†	.....	.....	300	*
French Gold Label	500	100	300	*
French Silver Label	11,000	100	12,000	Between 10 and 100
Bulk	400	*	1,400	*
Bulk	60,000	3,500	700	*
Bulk	1,000,000	120,000	750,000	At least 100,000
Bulk	2,500,000	50,000	900,000	*
Bulk	4,000,000	60,000	900,000	*
Bulk	11,000,000	8,000	6,800,000	*
Bulk	15,000,000	40,000	5,200,000	*

* None found on 0.1 gram. † Salesman's sample.

Experiment No. 2.

A batch of ice cream was made in a two-quart hand freezer, all parts and utensils being sterile. The materials used were: 1 liter sterile cream (½ hour at 15 lbs. steam pressure), ½ pound granulated sugar, ½ ounce vanilla powder, 3 beaten market eggs, and 1 ounce of gelatin.

The gelatin used was that showing a count of 11,000,000 on gelatin and 6,800,000 on agar media. This was dissolved by soaking and warming in sterile water below 40° C. before adding to the mixture. All bacterial results shown below were obtained on nutrient agar at 37.5° C., 48 hours, and in lactose bile 37.5° C., 72 hours.

The beaten eggs showed 300 colonies per cc. with no coli in 1 cc.

The vanilla powder showed 300,000 bacteria per gram with no coli on 0.1 gram.

The sugar yielded only 200 colonies per gram with no coli on 0.1 gram.

The ice cream made as above contained 120,000 bacteria per cc. with no coli in 1 cc. but present in 10 cc. portions.

Obviously this count is derived almost entirely from the gelatin, and is 82 per cent. of the number that we should expect to find, based on calculations taking into account the bacteria on the raw material and the volume of the mixture before freezing. Such calculation indicates that ½ pound sugar and 3 eggs per liter of cream have practically no effect, and vanilla powder comparatively little upon the number of organisms in ice cream.

Experiment No. 3.

The preceding experiment was repeated, omitting the eggs and using but ⅛ ounce gelatin.

The ice cream contained 15,000 bacteria per cc. with colon organisms present in 10 cc. but absent in 1 cc.

This amount of gelatin is somewhat higher than that usually used by manufacturers, and apparently such an amount furnishes only a small percentage of the bacteria ordinarily found in frozen milk products. Moreover, had the gelatin been dissolved by the usual method of scalding instead of by merely warming, the great majority of organisms found in this experiment would have been destroyed.

Experiment No. 4.

A batch of ice cream was made using 1 liter sterile cream, ½ pound sugar, and 1 ounce of vanilla powder.

Disregarding the very few organisms that might gain access from the air, the bacterial content of this ice cream is derived entirely from the vanilla powder, which in this case should yield 7,600 bacteria to each cubic centimeter of the ice cream. Of this number, 6,500 were found, with the colon bacillus present in 10 cc. and absent in 1 cc.

The three preceding experiments prove that the numbers of bacteria introduced by sugar, gelatin, eggs, and vanilla powder are but very small percentages of the numbers usually found in commercial ice creams, and it follows that the cream must furnish the vast majority of such organisms.

Experiment No. 5.

Ice cream was made with the following materials: 1 liter of raw cream containing 7,300,000 bacteria per cc. with colon bacilli present in 0.0001 cc. and absent in 0.00001 cc., ½ pound sugar, and 1 ounce vanilla powder. The resulting ice cream contained 11,000,000 bacteria per cc. and the same colon content as the raw cream.

The increased number in the frozen product is very likely due to unequal distribution of organisms. The results of other workers indicate no definite relationship between bacteria in the cream and in the ice cream,

the latter in some cases showing one half, in other cases three times the content of the cream.

Experiment No. 6.

A 1-liter portion of the raw cream used in the preceding experiment was pasteurized in a flask for 30 minutes at 143–146° Fahr. It was then cooled and allowed to stand 24 hours at 55–60° Fahr., in order to approach commercial conditions.

After this time, the pasteurized cream contained but 3,800 bacteria per cc. (99.9% efficiency) with no B. coli in 10 cc. Ice cream was then made from this cream, using ½ pound sugar and 1 ounce vanilla powder, and the frozen product contained 12,000 bacteria per cc. with colon bacilli present in 1 cc. but absent in 0.1 cc.

Conclusions.

The preceding experiments prove that sugar and eggs have practically no effect upon the bacterial content of ice cream. Vanilla powder and gelatin as ordinarily used introduce comparatively few bacteria, the great majority being derived from the cream.

Proper pasteurization of cream would yield ice creams which could easily comply with the 500,000 standard.

On account of the wide distribution of the colon bacillus, it appears that the best and most carefully prepared ice creams will show this organism in 10 cc. and occasionally in 1 cc. portions.

Those batches made from sterile cream had only a slightly scorched taste, not noticeable to the consumer until attention was called thereto. Properly pasteurized cream would not affect the taste of the ice creams.

Chemical Examinations.

All of the samples taken this year were examined for percentage of butter fat and for the presence of gelatin and starch, with results shown in Table No. 4. Tests for saccharin and foreign fats were negative in all cases.

Ohio has no fat standard for cream. As a result, the richness of our ice creams will not compare with that of localities where cream is legally defined. A standard for fat in ice cream should not be considered until cream standards are enforced, as the ice cream manufacturer is at the mercy of the milk dealer.

TABLE NO. 4.

Summary of Chemical Examinations.

Per cent. fat.	No. samples.	Per cent.		
Below 5.0	2	5.1		
5.1–7.5 inclusive	10	25.7		
7.6–10.0 inclusive	13	33.3	10% and below	64.1%
10.1–12.0 inclusive	2	5.1	12% and below	69.2%
12.1–14.0 inclusive	6	15.4	14% and below	84.6%
14.1–16.0 inclusive	4	10.3	Over 14%	15.4%
16.1–18.0 inclusive	2	5.1		
Over 18.0	0	0.0		
	39	100.0		

Minimum fat	4.2%
Maximum fat	17.4%

Per cent. of samples containing gelatin	51.3
Per cent. of samples containing starch	20.5
Per cent. of samples containing gelatin and starch	2.6

General Conclusions.

The bacterial content of ice cream is usually so high that studies of the cause are imperative.

Cream is obviously the source of the great majority of bacteria found in ice cream.

Proper pasteurization of the cream and enforcement of sanitary regulations will reduce the bacterial count in ice cream.

Pasteurization of the mixture just before freezing would bring about a still greater reduction. Pasteurized cream does not affect the taste of ice cream.

Sanitation at the dairy must not be neglected, but proper refrigeration and transportation facilities in large cities are far from satisfactory. A perfect product at the source of supply may be teeming with bacteria by the time it reaches its destination, and under the present conditions, pasteurization is the only remedy.

Chemical, bacteriological and sanitary standards for ice cream should be established and enforced. This would insure a cleaner and safer product for the public, give the physician some idea as to the quality and richness of the product for invalids and children, and place competition upon a fair basis by eliminating the unscrupulous manufacturer.

STUDY OF A SWIMMING POOL WITH A RETURN PURIFICATION SYSTEM.

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Read before the Laboratory Section of the American Public Health Association, Colorado Springs, September, 1913.

During the last five years, considerable interest has been aroused concerning the sanitation of the indoor swimming pool. More or less thorough investigations have been made in a number of places and in particular the effect of hypochlorite as a cleansing agent has been studied both from a chemical and a bacteriological standpoint. In most of the pools so investigated, water has been obtainable in practically unlimited quantities, and in general it has been the policy of those in charge of such pools to completely empty and refill the tanks about once a week.

There are, however, many places where the cost makes such a frequent change of water well nigh prohibitive, where the time consumed in this way interfers with the use of the pool, or where the necessary amount of water is not available. Such conditions exist for the most part in connection with Y. M. C. A. and social center organizations. Many of these have installed some sort of purification systems whereby water is returned to the pool after passing through a filter. Hypochlorite is sometimes used in addition; in some cases hypochlorite is used alone without any filtration.

During the winter of 1913 the author had the opportunity to make a sanitary study of the Cambridge (Mass.) Y. M. C. A. pool, and the results seemed of sufficient interest to report.

That a swimming pool should be kept clean is obvious, but if there are any doubts they will be quickly dispelled by a survey of reported cases of both intestinal and external infection which have been traced beyond reasonable doubt to bathing or swimming in polluted water. For this you are referred to a paper by Atkins in the Proceedings of the Illinois Water Supply Association for 1911.

Cleanliness in a swimming pool can be divided into two kinds, physical and bacteriological. To a large extent these two are interwoven, but at the same time the author knows of at least one pool where a purifying system was installed in order merely to remove the color from the water. No one cares to swim in a highly colored or turbid pool any more than they care to drink such water even if assurance is given that the water is perfectly safe. Unfortunately, most people are not so particular about outdoor bathing. The problem, then, for the caretaker of a pool is twofold: to keep the water and sides and bottom of the tank in good physical con-

dition; and to sterilize or purify the water sufficiently to remove danger of infection. In the pool about to be described, a fairly successful attempt was made to do both of these.

The Harvard tank at the Cambridge Y. M. C. A. is 60 feet long by 20 feet wide and varies in depth from $3\frac{1}{2}$ to 7 feet. The capacity is 55,000 gallons. The water is supplied by an artesian well on the premises about 400 feet deep, through a pump of 50 gallons a minute capacity. Around the tank, just above the water line, is a splash board connected with the sewer except at the shallow end of the tank where it serves as a trough to admit water to the pool. The outlet is in the bottom of the tank near the deep end. The purification system consists of a closed filter 6 feet high and $4\frac{1}{2}$ feet in diameter filled with quartz pebbles through which water from the tank may be pumped at the rate of 50 gallons per minute. This means a rate of 63 million gallons per acre per day. In front of the filter is a by-pass, controlled by a needle valve, leading through a cylinder filled with sulphate of alum. The alum is thus dissolved slowly and mixed with the main supply from the tank. The amount used varies from one-fifth to one-half a grain per gallon. The filtration is carried on only during the day time. The filter is cleaned each day by reversing the current. When necessary, the filtered water is passed through a heating coil in order to keep the temperature of the tank as nearly as possible at 70° F.

At night, after all users have left the pool and the filter shut off, one pound of hypochlorite of lime is dissolved in the water by wrapping it in a piece of cheese cloth attached to the end of a pole which is moved about the surface of the pool. The water remains quiet during the night. The first thing in the morning the sides and bottom of the tank are cleaned by a brush connected with a suction pump—an arrangement similar to the ordinary vacuum cleaner. Then enough water is added from the well, usually about 5,000 gallons, to replace that lost by splashing the day before and by the cleaning process.

The number of users of the tank is smaller than in many places, being from 400 to 500 each week. As usual, a shower bath is required before entrance to the pool.

The test was carried on in the following manner. The tank was completely emptied and the sides and bottom cleaned. It was then filled with the artesian well water, a sample of which was collected and examined both chemically and bacteriologically. The filling required about eighteen hours. The first sample was then collected from the tank. As previous observers had shown that there was little variation in the water in different parts of such a tank, one sample only was collected from about the middle of the tank. The tank was then thrown open for use and the filtration started. No hypochlorite was used for two days during which time 125 swimmers used the pool. The second sample was then taken. This was immediately

followed by the addition of hypochlorite. Samples were then collected at first twice a week and later once a week at noon on the days mentioned. This was done in order to observe the condition of the pool at the time users first entered it, and was thought to be the best way to show the effect of the purifying system.

The following examinations were made: physical—color, odor, turbidity and sediment; bacteriological—total count on nutrient agar at 20° C., and on lactose litmus agar at 37°, acid colonies on the latter medium, and gas production in dextrose broth; chemical—nitrogen as free ammonia, albuminoid ammonia, nitrites and nitrates; chlorine, and oxygen consumed. The results are given in the following table:

		Bacteriological Results.				Chemical Results. (Parts per million.)						
						Nitrogen as						
No.	Date.	Agar at 20°. No. per cc.	Litmus lactose agar at 37°. No. per cc.	Gas formers per 5 cc.	Acid colonies per cc.	Free NH_3.	Alb. NH_3.	Nitrites.	Nitrates.	Chlorine.	Oxygen consumed.	Remarks.
1	Feb. 24	110	200	0	0	0.001	0.014	0.0	0.09	30.8	0.29	Artesian well supply.
2	Feb. 24	6,000	7,000	1	..	0.006	0.026	0.0	0.12	31.6	0.29	Swimming tank.
3	Feb. 26	4,300	6,500	10	..	.....	.....	.....	.....	29.6	....	No hypochlorite added.
4	March 3	20	140	0	..	0.022	0.072	0.001	0.18	33.2	0.48	Hypochlorite added on March 2.
5	March 6	12,000	20,000	1	..	.....	.....	.....	.....	36.0	....	Suspension of alum noticed in tank.
6	March 10	3,500	18,000	1	..	0.143	0.100	0.002	0.24	34.4	0.67	
7	March 13	.....	.....	0	0	.....	.....	.....	.....	.....	.....	Water clear again.
8	March 17	6	6	0	0	.....	.....	.....	.....	.....	.....	
9	March 20	42,000	30,000	0	0	0.054	0.056	0.0015	0.15	40.0	0.95	
10	March 27	150,000	180,000	10	40	0.280	0.070	0.010	0.10	42.4	0.71	
11	April 3	398,000	300,000	3	20	0.066	0.112	0.400	0.10	31.2	0.95	
12	April 10	180,000	50,000	0	0	0.096	0.060	0.200	0.13	36.0	0.83	

We realize that this data is not as complete as we would desire but certain tendencies seem to be quite evident. These will be shortly described.

Tests were also made to determine the bacterial reduction in the filter and heating coil. Samples were collected before the water entered the filter, between the filter and the heating coil and just after the coil. The results follow:

BEFORE ENTERING FILTER.

	Bacteria per cc.
Agar at 20°	454,000
Litmus lactose agar at 37°	330,000
Acid colonies	12

AFTER PASSING FILTER.

Agar at 20°	88,000
Litmus lactose agar at 37°	75,000
Acid colonies	5

AFTER PASSING HEATING COIL.

Agar at 20°	2,700
Litmus lactose agar at 37°	1,200
Acid colonies	0

The percentage removal of bacteria by the filter was 80 per cent. and by the heating coil also 80 per cent. making a total removal of 99.5 per cent. The actual number of bacteria in the tank cannot, however, be reduced this amount, although there is undoubtedly help from this source.

The results of the physical examination can be briefly dismissed. At no time was any color or odor observed in the water, except for a slight odor of chlorine once noticed when a sample was collected. No complaint on this point was ever received from any swimmers. The water was clear and free from sediment except for a short period when particles of alum were noticed in the tank. A reduction in the amount of alum used in the filter overcame this trouble.

A study of the bacterial and chemical data shows several points of interest. A swimming pool is an ideal incubator for bacteria, particularly those coming from the body, on account of the favorable temperature and the presence of food material constantly being supplied from the users of the pool.

Addition by hypochlorite causes an immediate reduction in the number of bacteria, and this number is kept down by this and the rest of the purifying system, to a reasonable limit for about four weeks. The same thing is true of gas-forming organisms. In the opinion of the author the two main factors in keeping the bacterial count low are the addition of the hypochlorite and the sedimentation which takes place during the night when the tank is out of use, this latter being followed by efficient cleaning. After about four weeks, practically all of the colonies on the plates were of a yellow chromogenic bacillus, which was not further identified. We believe that this organism gradually developed a resistance to hypochlorite, and could be eliminated only by emptying and cleaning the tank. The reduction in number of bacteria noticed in the last sample taken we were unable to follow up as it was thought best to empty the tank. Attempts were made to isolate the Staphylococcus from some colonies on the agar plates, but in only one instance was this successful.

Chlorides are not an index of the pollution of a swimming pool, as the variation from the original water was only slight and did not correspond with the bacterial results. This has been noticed by others.

The determination of the free ammonia gives a partial but not entirely satisfactory index of the gas-forming organisms present.

The best index of the bacterial pollution is given by the nitrite determination. This relation between nitrites and total count of bacteria is shown very clearly if the results are plotted. The mathematical relation, nitrogen as nitrites times one million equals total bacteria, may have been only a coincidence.

The whole question as to what standards should be employed for swimming pools is an open one. Although the chances for infection are probably less than in the case of drinking water, still the demand for "clean" water as well as for water free from sewage should be made just as strongly in the case of swimming and bathing as in the case of drinking. That gas-forming organisms alone cannot be used as an index of safety for swimming is evident from the fact that some of the bacteria producing external infections do not come under this head. We feel that more data is needed before any definite standard can be suggested.

I have been assisted in this work by Mr. G. T. Lane, to whom thanks are due for his suggestions and industry.

THE FUTURE OF THE MILK INDUSTRY.

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Health Commissioner, Buffalo, N. Y.

Read before American Public Health Association, Colorado Springs, September, 1913.

No time need be occupied by me before this audience in detailing the particular character of milk, its extensive use, nor its intimate relationship with sickness and public health. I need not waste any time in relating how and where it is contaminated, nor what conditions should pertain to prevent it.

We know that from 10 per cent. to 50 per cent., and even more, of the herds are infected with tuberculosis; that 5 per cent. to 10 per cent. of the raw market milk contains virulent tubercular bacilli, and that it is frequently the media for other infections, and that its bacterial count is generally detrimentally high; and as a consequence of these conditions, it is responsible for thousands of infantile deaths yearly, for a greater part of tuberculosis in childhood, and for a certain proportion of typhoid and other infections.

With these facts in mind, the problem is what way is best to mitigate the conditions and lessen the consequences.

Five years ago, the Buffalo Health Department established a Dairy Farm inspection service, organized and systematized the work of milk supervision, which up to that time had not been feasible.

Recognizing the difficulty in attempting radical changes among a class who largely are very slow to make innovations, unfamiliar with sanitation, and unmindful of the responsibility of milk production, it was determined to limit the requirements to the elementary essentials of cleanliness, care and cooling, and that the requirements for health itself should be sufficiently reasonable to permit general compliance. In other words, not to aim for ideal conditions but to obtain coöperation and betterment gradually and by appeal.

It was aimed to make the inspection educational as much as possible, and to stimulate interest in clean milk by a rational common-sense attitude.

Every kind of unsanitation and undesirable methods were found, with the small producers the greatest offenders; the most difficulty was found in obtaining milk houses and securing their being used, of getting the milk work out of the barn, and introducing the covered milk pail.

Results as a whole have been satisfactory. At the time the work was inaugurated, there were two thousand (2,000) farmers shipping milk, consequent upon inspection the number has been reduced to 1,200. Before supervision, the bacterial count of milk was detrimentally high. Up to

the present time, from 60 per cent. to 70 per cent. is received within the limit of acceptance.

Deductions from the work justify the following:

First. That protection from milk possibilities cannot, under present conditions, be obtained at the dairy farm. Producers are not of a type to appreciate the responsibility, nor to consider other than the commercial side, and the margin of profit which is too small.

Second. The retarding element in betterment of the whole is the small producer who keeps cows largely for manure, whose milk is a minor production, to whom sanitation does not appeal, and from whom compliance is wanting. Their elimination at this time is not feasible without causing a serious shortage in the supply. The policy should be to foster the large producer, who makes milk the principal business, to gradually eliminate the minor one referred to, and the best method to accomplish this is through the permit system.

Third. In order to secure improvement in dairy farm conditions, it is necessary to secure the coöperation of the allied industries, creameries, butter and cheese factories, and likewise the city dealers. As long as a producer, whose product has been rejected by the city, can find a market elsewhere, sanitary correction for improvement will not be made. Likewise it is indicated that there should be a uniform standard of production for milk throughout the state, and between states that are in close association.

Fourth. A most important indication is that coöperation and a definite system of notification between the state authorities and municipalities be maintained in regard to contagious diseases. This deficiency on the part of the state officers is very unsatisfactory. The presence of contagious disease at a dairy farm at the present time is rarely reported by the health officer, and discovery is more often the result of accident, or through outside sources of information. I have spoken on this subject several times before and the New York State Health Department has taken some action on the suggestion.

Fifth. It is in evidence that methods are of far greater importance in production of clean milk than equipment. Some of the best milks coming to the city are from poorly equipped farms but where cleanliness is maintained.

Sixth. That the testing of cattle for tuberculosis is not feasible from the farmer on account of expense and loss of cattle. The serious indication at the present time is protection from tuberculosis through milk. Desirable as it might be, the elimination of infected animals is not feasible, owing to economic reasons, milk shortage, etc. The most practicable method of meeting the situation is by classification of milk and pasteurization. All animals should be tested, and by the state, and the milk pas-

teurized in accordance; and the city should pasteurize all milk not known to come from sound animals. The pros and cons of pasteurization are well known. It is believed, however, that with the present improved facilities for pasteurization by the holding method, it is feasible commercially, and is efficient, safe and desirable, and that there are no practical objections if it is done under proper municipal supervision with specific requirements.

While the public is interested as never before in sanitation and also in milk, the conditions and appreciation in many lines are not fully recognized.

The explanation is that the method of diffusing knowledge is deficient and not systematized. Many health authorities publish valued bulletins containing just the information desired, but it does not reach the body of readers it should. Publicity should be one of the important functions of the health department, as it is one of the most valuable aids in securing results. It is believed that the department should make provision for a certain amount of space in the daily newspapers, and either weekly or monthly, and at stated intervals, publish pertinent matter in the public interest; and, further, that other agencies for disseminating information should be effected. In this way, only, the largest number of people could be reached. It is, therefore, indicated that the departments should maintain a division of publicity and utilize the press; in brief, to avail themselves of every method to advertise health and disseminate sanitary knowledge.

No more important work belongs to the city dealer than the sterilization of the can. To secure acceptable conditions requires constant scrutiny. While the large dealers have facilities and proper methods, the small dealer is wanting. The propriety of maintaining a municipal can-sterilizing outfit located near or adjacent to the railroad station has been under consideration, all cans to be steamed out before they are returned to the country. It is ascertained that such a plant can be made self-supporting and would be readily availed of by dealers who would gladly omit this part of their work.

The small milk dealer, as with the small producer, represents the retarding element of improvement in the milk business. Indications are that the near future will determine the passing away of the small dealer.

With the public demanding a safe milk, with requirements by authorities for conditions to make it so, the small dealer will be unable to comply and by the "survival of the fittest," will gradually be displaced.

Safe milk can only be obtained at an increased cost. Sanitation and cleanliness mean expense. When the public are educated to this point, there will be a demand and supply. But to a large number, increased cost of milk means going without, or its limited use, or the using of prepared milks.

There is no objection to condensed and evaporated milk, provided it is used under proper conditions and is of a definite standard of composition.

Use of powdered milk will appear to be one of the most promising indications; 90 per cent. of milk is water; its value remains in the other 10 per cent. The cost of shipping and handling 90 per cent. of water is a matter of no small importance. There is no question but what the use of powdered milk may offer a solution to a great part of the problem of supplying safe milk at a low cost.

It has the advantage of concentration-keeping properties, and can be made of any degree of richness. At present it is extensively used in industries and by the government. It may determine the availability of supply from distant points.

Few businesses are so directly related to the public health as the milk business, yet the occupation is open to any and all classes who have sufficient capital to equip moderate-sized places and buy a few cans of milk. As compared with other businesses in their capacity for detriment, the druggist may poison or sicken an individual; a plumber, through defective work, a household; but the milk dealer, within a few hours, can disseminate infection throughout his entire route. If it is deemed wise in the interests of the public to license a plumber or pharmacist, how much more is it not important to license a milk dealer? To this end, it is suggested that cities have a milk dealer's licensing board, analogous to the plumbing and pharmaceutical boards, that would be representative and appointive by a disinterested party, the county judge; that he designate two members from representative milk dealers, two others, one a physician from this general public, and that the Health Commissioner designate a member of the Health Department and thus constitute a Board of Examiners. Require each person engaging in the business to obtain a license from this board, and make it a condition that he give a satisfactory knowledge of milk and its relations to the public, and an intelligent understanding of cleanliness and why cleanliness should pertain. It is believed that a requirement of this character will be followed by beneficial results. A dealer with sufficient qualifications could do things understandingly, could appreciate the reasons for the health department's action, and would be a coöperative agent rather than an evader. In all cities, there are dealers who are coöperative with the Health Department milk officials and others who are not, and with the body of dealers as a whole there is more or less lack of information as to the reason of things and a mechanical way of doing same. Betterment in this line can be obtained by the health department conducting a school of instruction for dealers, or a course of lectures teaching the elementary facts in a plain and readily understood manner, say during the winter months. Such instruction could be illus-

trated and simple experiments could be used. The necessity for education is even of greater importance to the dairy farmer. While it is not within the province of the city to go into the country and conduct a campaign of education, it certainly would appear to be the province of the state to do so. A corps of instructors should go through the dairy section and give instruction at stated intervals through the Grange and other associations. It has been suggested that a car be equipped, illustrating the modern sanitary dairy and all the stages of the handling of the milk up to the consumer. In this way, there would be organized a school which would, without doubt, be of great interest to the dairymen and be of profit to the communities.

The householder's care of health is notably wanting. This is the most difficult of all to secure improvements in. One is at a loss to know just how and what would appeal to the average householder. A thought, however, has occurred that through the school children, the householder would be interested more than through many other sources, particularly with the lower and foreign classes, who attribute great importance to everything coming through the schools. It is known that directions of the teacher brought home carry a greater weight and influence not exceeded by any other. If the children were taught the basic elements and instructed to endeavor to secure them at home, it would be an influence.

Another thought is to make a milk bottle an educator, and to have an educational label on each bottle, at stated intervals during certain seasons, with pertinent axioms on it. The bottle coming regularly with its message of instruction would possibly, finally, make an impression. In other words, make the milk bottle an educator as well as a container.

It is believed, also, that if milk dealers would coöperate more by consulting the department records in making contracts by dealing only with farmers whose facilities are acceptable to the department and by requiring in their contracts that certain conditions and uses be maintained, it would be an advantage. If the body of milk dealers followed these lines, farmers would be more responsive. It would also be an advantage if dealers would avail themselves of the health department laboratories to a greater extent. The average health department's facilities for scrutinizing milk are limited. If each dealer reports the condition of his milk when it is not right to the department, it would be an auxiliary aid of value.

Of course, much more could be said on the future of the milk industry and anyone looking over the bulletins issued by the various health departments, dairy bureaus and agricultural associations and divisions, schools, etc., would find some of the ideas which would be of ultimate usefulness and would tend to improve the milk. However, this sketch, in addition to the several I have written on the same subject, is one which I hope and believe deserves some consideration at the hands of interested parties.

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DOLLARS *VERSUS* DEATHS.

The art of sanitation has a widely different basis from those applied sciences which draw their conclusions on mathematical principles. An engineer can calculate to a nicety the cost of a city lighting plant, the cost of its maintenance, and the exact results which will be obtained; and the corporation employing him will be able to determine closely what return the money invested will bring. The sanitarian, on the other hand, while he deals with the costs of public health work in hard cold dollars, finds on the results side of his accounts savings in deaths which cannot be determined precisely, savings in sickness which are still less exact, and sociological and sentimental factors which cannot be determined at all. The biological sciences upon which sanitation is based and the human

material upon which it operates are in their very nature insusceptible of mathematical precision; even the results of vital statistics, "the bookkeeping of public health work," require analysis and interpretation which takes account of the fluctuations and inexactitudes of their original data.

Statistics are, however, becoming constantly more accurate and sanitary science more quantitative. Health officers make predictions and promises with more confidence and certainty. And now from Rocky Ford, Colorado, comes a proposal unique in its courage. The health officer of that community, having surveyed the public health situation and made his specific recommendations, addressed his board as follows:

"You gentlemen, as the board of health and legislative council of this community, are directly responsible, and I as your executive officer if I fail to do my part, if another epidemic of typhoid breaks out in our town. . . . I wish I could force this home upon the conscience of every state and municipal legislator in Colorado. . . . A quarter of a century ago this could not have been said. But increasing knowledge brings increased responsibility. . . . This matter cannot be waved aside as a visionary ideal based on impractical theories. . . . We act today on facts. The visionaries were the Pasteurs, the Listers and Flints of the generation preceding us. . . . They were true prophets. . . . So confident am I that what I tell you can be made true here, that I make you this offer. We will take the year of 1913 as a basis; give me the ordinances and regulations, I ask, with authority and funds to enforce them; give me a competent salary so that I may devote my whole time to public health work; if the death rate during the third year is not less by at least three to the thousand, I will return the amount of my salary to the city, and I will put up a bond in the beginning to secure you."

Bold words these, of the sort that shake the inertia of lagging town and city governments. How far the proposal in this particular case is justified we do not presume to judge; the health officer of Rocky Ford has doubtless reckoned up his conditions before making his predictions. The significant point is, as he remarks, that a quarter of a century ago no health officer would have dreamed of making such a promise; today the mere fact that it is made by even one health officer is a sign of the times.

The offer was not accepted and the prediction tested, but with the data now available from fields where definite results have been obtained from definite expenditures and efforts—measured reductions in typhoid fever, diphtheria, and other communicable diseases, in infant mortality, and even in slowly yielding tuberculosis—quantitative forecasts conservatively based on sound data are certainly justified. Already the time is foreshadowed when vital statistics will be comparable in exactitude with financial statistics, and when any excess above an accurately determined "normal" death rate for each community will be regarded as a mark of culpable municipal negligence.

THE INFLUENCE OF THE FINANCIAL STIMULUS IN THE IMPROVEMENT OF A CITY MILK SUPPLY.

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Department of Dairy Husbandry, University of Illinois.

Read before the American Public Health Association, Colorado Springs, September, 1913.

The sanitarian is constantly engrossed in the problems of life and death and he is inclined to resent any attempt to place a financial estimate upon either the life to be saved or the expense of saving it.

Whenever he has made distinct progress in the task which he has undertaken, there has been little disposition to question either his methods or the expense involved. On the other hand, where he has expended large sums of money and produced few tangible results, the layman has been prone to inquire whether some less expensive and more productive methods may not be used.

There is no question but that in many cities the falsification of milk through skimming and watering has been reduced and the conditions under which milk is being handled at the city end has been materially improved. However, when we consider the condition of the milk as it rea hes the city, the improvement has been less marked.

Practically every year some city rises up and proclaims that at least in the matter of a milk supply it has joined the elect. When some outsider studies the situation he finds himself in the condition of the spectators before the fabled weavers who were making the cloth, visible only to those who are perfect, and like the spectators in the fable he goes away saddened because he is unable to detect that which he has heard so loudly proclaimed.

As the result of such experiences there has gradually grown up the conviction that the milk supply which is now reaching our cities is undergoing little or no actual improvement. Tuberculosis of dairy cattle is spreading rapidly in practically every dairy state, the amount of cow dung in the milk is being reduced little if at all and the proportion of digestible solids or food value of the milk is steadily falling.

Such being the conditions of the milk supplies it is perhaps not impertinent to suggest that a consideration of the milk question from the economic standpoint may be worth while.

Few hygienists have given careful attention to the economic side of the milk question. Some light is thrown on this side by a recent study made by the New York Agricultural Experiment Station of the milk supply of a city of 13,000. The capital invested in the local milk business was approxi-

mately one half a million dollars or slightly less than $40 per capita of the city population. Apply this figure to your own population and note the financial magnitude of the business you are undertaking to control. Considered from the agricultural standpoint the capitalization amounts to $763 per cow of which the producer of milk furnishes $680 and the retailer $83. On the basis of observed yields of milk, the farmer must receive 3.5 cents per quart to pay for 6 per cent. interest on his investment and the feed of the cows. Now it happens that 3.5 cents per quart is approximately the average wholesale price of city milk in that region so that on the average the farmer gets merely the manure in exchange for his labor. Truly an unsavory reward for long hours and steady toil.

Under such conditions, the farmer is driven to produce milk in the cheapest possible way. Since milk is quite uniformly purchased by weight or measure regardless of the proportion of fat or other solids, the farmer is compelled to use those breeds which will furnish the largest permissible proportion of water. Failing in these, he adds the water himself, reducing the milk to the lowest amount which will pass the legal standards. Time is money and time spent in cleaning the cows or their surroundings is largely wasted since it brings to the farmer no adequate return in increased market price. On the contrary, foreign matter added to the milk contributes its bulk or weight to the net returns of the market. With these economic forces actively crowding the farmer 365 days in the year, the annual or semi-annual visits of the city inspector make little impression upon the sanitary conditions surrounding the production of the city milk.

If this economic situation is rightly appreciated, it offers the finest opportunity for a steady improvement of milk supplies. Because the basis of payment is weight or measure alone, every economic force now demands the production of cheap, dirty milk. However, under present conditions, the production of even the dirtiest milk leaves little or no margin for profit. Herein is the key to the situation since but a slight change of factors might make the cleaner milk the more profitable.

The delicateness of this balance is illustrated by the experience of one of the large city milk companies. They have found that a bonus of only 10 cents per hundred pounds added to the wholesale price of milk when certain sanitary conditions were changed has worked a remarkable improvement in their milk supply.

There is a growing desire on the part of the public for a safer milk. It is extremely difficult to utilize this desire under present conditions because we have no simple method of informing the people of the relative desirability of the various milks which are upon the market. In the case of the city above referred to, this was met by publishing the score card rating of the dairies. Within a short time the farmers were being paid on a sliding scale, both the producers and the retailers having voluntarily accepted the official score as the basis of payment.

The scoring of the city's milk supply at the beginning of the experiment is given in the chart for 1907, the scorings having been made during the last quarter of that year. This shows that the sanitary conditions in 37.5 per cent. of the dairies were poor, in 57.5 per cent. they were medium and in 5 per cent. they were good. The succeeding chart gives the scorings at the first quarter in 1911 when the sanitary conditions of 87.2 per cent. of the dairies were *good* and 12.8 per cent. were *excellent*.

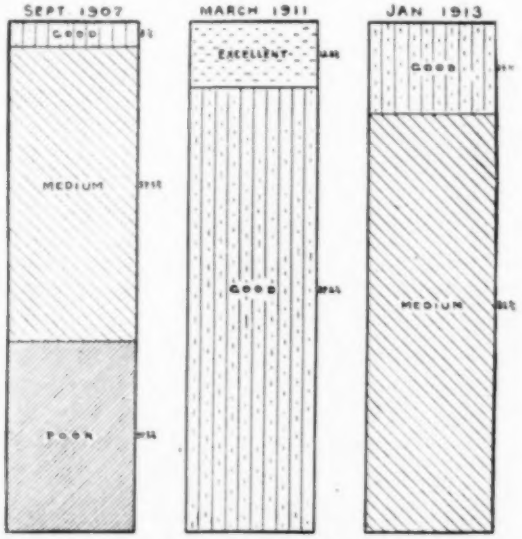


Fig. 1.—Change in Sanitary Quality of City Milk Supply.

In 1911, coincident with one of those changes in municipal affairs, which frequently occur, the scoring was placed in the hands of parties unfamiliar with such work. Under such circumstances it was natural that the inspector should repeat the scores previously given to each dairy. The farmers, finding the score of their milk, and that therefore the price which they would receive for it was no longer dependent upon the sanitary conditions of their dairies, relaxed their efforts.

The sanitary conditions actually surrounding the dairies in January, 1913, on the same basis as shown on the earlier charts is given on the chart for 1913 as 82 per cent. *medium* and 18 per cent. *good*.

Under the combined influence of publicity and the financial stimulus, during four years, this milk supply steadily and markedly improved, but within two years after the financial stimulus was removed, it returned to practically its original conditions. Since the other factors remain essentially the same, this is a good demonstration that the financial stimulus is really the controlling influence in determining the quality of our city milk supplies.

The objection will be raised by the practical sanitarian that financial considerations are outside of their jurisdiction and that it is well-nigh impossible to apply the financial stimulus to the milk business. To the first it should be said that the business of the sanitarian is to safeguard the public health and he should adopt the best methods for accomplishing this end which are open to him. To the second objection, it can be said that, since it has been done, it can be done again, and undoubtedly done much more thoroughly.

The stumbling block in the application of this financial line of attack is the absence of simple and direct means by which we can grade milk in accord with the uses to which it is to be put. The method of grading used in this study was crude and took into account only a portion of the factors which together determine the commercial quality of the milk.

A committee of the Official Dairy Instructors' Association has been charged with the task of perfecting this method of grading until it shall be capable of accurately placing the product of a given dairy in the market class in which the milk from that dairy should be sold, provided it is so handled after leaving the dairy as not to depress its market value.

Since this association is made up of Agricultural Experiment Station men, and is, therefore, most representative of the milk producers, this committee has associated with itself representatives of the retailers and of the Public Health men, representing the consumers, thinking in this way to reach a final result which shall be satisfactory to all parties.

In carrying on this work, I trust that we shall have your best wishes and active coöperation.

MUNICIPAL VERSUS CONTRACT STREET CLEANING IN WASHINGTON, D. C.

J. W. PAXTON.

Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

Washington, the Nation's capital, is among the few of the important cities of this country—and probably the latest one—to abolish altogether the practice of performing its street cleaning operations under contract, and to take over such operations as a municipal function.

The contract system had been in vogue since the establishment of the present system of government, when, on recommendation of the commissioners of the District of Columbia, Congress, by an act of March 2, 1911, authorized the said commissioners to undertake the work when "In their judgment" it could be accomplished more advantageously to the interests of the District of Columbia.

Accordingly, such operations were commenced as a municipal function on July 1, 1911.

Necessarily during the first year the department was put to considerable expense towards the purchase of new equipment, horses, etc., and naturally many experiments were resorted to and changes made before the forces engaged in the work could be properly organized for so important a task. Notwithstanding these changes in methods as the work progressed, which necessarily impaired the maximum efficiency of the force engaged, but which were dictated by knowledge gained by experience, and notwithstanding also the considerable expense attached to the purchase of new equipment, the office was able to show at the end of the first year's operations that the average costs were less than the contract prices.

At the end of the second year, June 30, 1913, the records disclosed that for the expenditure of the same amount of money, over 25 per cent. more work was accomplished than during the last year of the contract system.

Unfortunately, the quality of the work, being a matter of observation and judgment, cannot be shown in figures, but the whole interest of the municipal authorities in charge of street cleaning, is to have the work well done, while the object of the contractor was to do it well enough to be paid. The stock is largely supplied by horses from the fire and police departments which have become unfit for fast work but are splendidly able to do the work of street cleaning and were originally the best that could be bought. They are kept better and fed better than the contractor's horses. All equipment is kept in perfect condition. The men are well paid, work hard, are employed and discharged according to their ability to work; and thoroughness at all times is insisted on. There seems to be no reason then for the efficiency being less, and the testimony of old employees of the department and impartial citizens who have been sufficiently interested to

observe, is that the streets are in better condition now than they have ever been before.

There are a few general principles which led the authorities in Washington to believe that street cleaning could be done more economically and efficiently by the municipality direct than by contract. They have been proved to be correct by actual experience and being applicable to street cleaning in other cities, the following effort to set them forth may be of interest.

Contractors exist only because they have special knowledge and equipment for doing certain work, acquired through the regular practice of doing similar work, while the other party to the contract is otherwise regularly engaged and only occasionally desires work done which the contractor makes a specialty of.

Apparently this condition does not apply to street cleaning. The work is done every day, year in and year out. There is no question about the municipality being able to finance the operation or purchase the necessary equipment, property, etc. It should be possible to develop and educate the organization far ahead of that of any contractor, especially if the terms of the contracts are short and there is enough competition to make changes in contractors probable.

This being almost entirely a labor contract, it would not be unusual for a contractor to figure 20 per cent. profit, which is more liable to be increased than diminished through insufficient, careless, ignorant or dishonest inspection.

Street cleaning is probably the most difficult work to inspect of any which could be let under contract. No street is ever perfectly clean, only relatively so, depending on the accumulation of dirt and the amount of efficient cleaning. It is impracticable to specify that the contractor shall furnish clean streets or even clean streets at certain periods, but each detail of the required operation of street cleaning must be specified, inspected to see that each detail is carried out, and the city then must be satisfied with results. In order to obtain efficient inspection in Washington under the contract system, it was found necessary in addition to general supervision, accounting, etc., to have an inspector with each gang of cleaners.

Under contract, the necessity for the study of this problem is not usually fully realized by the municipal authorities, and they are invariably unprepared to specify in detail the work which is to be required of the contractor. Sufficient opportunity for experiment and observation is not afforded and therefore improvements are not often discovered. Even if improvements are discovered, changes are difficult, if not impossible, and resulting economy would benefit the contractor and not the city.

On the other hand, when the municipal authorities are directly responsible for the work, it is up to them to make good. All the details intrude

themselves on their notice, changes can be made immediately and the city at once receives the benefit.

For example, under the contract system in Washington changes occurred very slowly and usually only when specifications were made up for new contracts, once in five years, but in the municipal work of the last two years, improvements have been of daily occurrence. Each blockman's work has been studied individually. Time studies with odometers have been made of all vehicular movement. Collections are all made working towards the dumps. Schedules are arranged for all machines, squeegees, flushers, etc., so as to do effective work every moment from the time they leave the stable until their return. Each gang is arranged so as to have the number of sprinklers, machines, broomers, shovelers, carts, etc., in proper proportion. It has been found that some of the wider alleys can be swept to advantage with one-horse brooms, and schedules have been very carefully arranged so as little time will be lost as possible in going from one alley to another. The area of each square, intersection and alley, has been carefully computed and card indexed, and a cost-keeping system has been established in order that comparisons can be made of the cost of cleaning per thousand square yards, each month or oftener, with the similar costs in previous months; or one foreman's work with another doing similar work; or one method of cleaning with another. The office is supplied with a multigraph printing machine so that schedules may be changed and reprinted on a day's notice.

The most radical change in methods has been to increase the hand cleaning combined with an occasional washing and to decrease the machine broom cleaning. The machine brooms raise so much dust that heavy sprinkling is required, the fine dust mixes with the water producing mud, which is smeared on the street by the broom, and when this becomes dry, it turns to dust again. The brooms sweep only the coarser particles and many of these are thrown over the broom by centrifugal force, to the pavement again. Hand cleaning work is capable of better distribution than any other method, because more attention can be given to the dirtier areas by increasing the number of men, who only clean the portions of the street which are dirty and work on these portions until they are clean. There is a fine scum which becomes plastered to the pavements, particularly sheet asphalt, which is not apparent when the pavements are dry but rises up in a thin sheet of mud when moist, making the pavements very slippery. This and fine dust cannot be removed by the hand cleaners, but by washing about twice per week, in addition to hand cleaning, these troubles can be eliminated.

Lastly, but not so important, are the contractors' risks, particularly in lump sum contracts, which the city must pay for, due to the possibility of increasing and shifting business and population, but principally on account of unusual seasons or weather.

TYPHOID FEVER EPIDEMIC—CENTRALIA, WASHINGTON.

EUGENE R. KELLEY, M.D., *State Commissioner of Health, Seattle, Wash.*,
and
STANLEY MACOMBER, C.E., *City Engineer, Centralia, Wash.*

Centralia, locally known as one of the Twin Cities of Lewis County, Washington, and of recent general interest because of a typhoid fever epidemic, is located midway between Portland and Seattle, and derives its support largely through its large natural resources of timber, coal and agricultural lands. It has an estimated population of about 10,000.

The original water distributing system of the city was installed about twenty years ago, the supply being taken from an open well, thirty feet deep, on the bank of the Skookumchuck River. Since the first installation a second open well has been dug and seventy 2″ drive wells sunk. These wells are located in a porous gravel sub-soil.

The Skookumchuck coming out of the mountains runs through some twenty miles of very flat, cultivated valley land, the watershed is quite thickly settled for ten miles above Centralia, and there are a few settlements further up. This condition subjects the river water at the pumping station to serious possibility of contamination, although no evil effects had been observed from contamination for twenty-three years until the recent typhoid epidemic.

PROGRESS AND EXTENT OF EPIDEMIC.

On November 1, 1913, the city health officer of Centralia had no cases of typhoid notified. Subsequent investigation seems to corroborate the correctness of the official record.

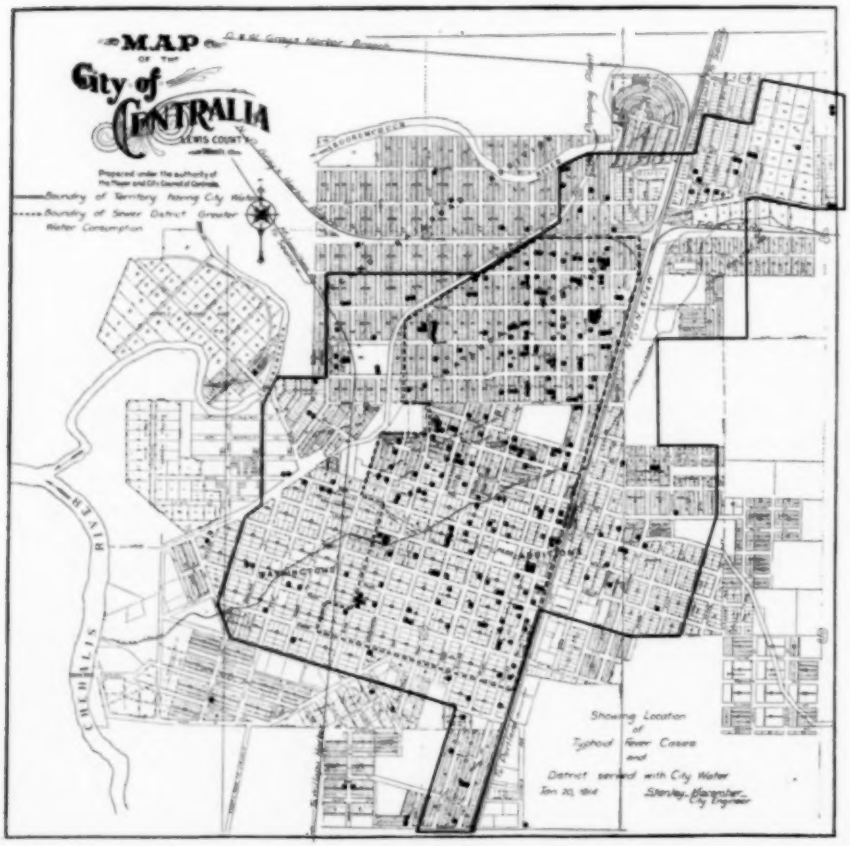
Fourteen cases of typhoid were observed by the local profession between November 1 and 10. This is a number in excess of the average for this city for many years.

For the period from November 10 to November 25 few new cases were reported. From the latter date on, cases increased very rapidly.

There is no evidence that the group of early November cases had any causative relation to the principal outbreak. Whether this preliminary group represents an infection through water of much milder intensity than the later infection, or is to be attributed to other causative factors than water, cannot be definitely decided, but it is very interesting to note that there were two distinct periods of high water in the river, one about the middle of October and the other three weeks later. It would seem at least a reasonable hypothesis that the earlier period of high water might have carried just enough infected material into the city water to affect the extremely susceptible only, while the later freshet carried a more massive dosage, affecting practically all the susceptible portion of the population.

There was no epidemic of diarrhea prior to the epidemic.

In the first week of December the city health officer was struck by the unusually large number of typhoid cases he had seen in his own practice for the preceding few days, and called upon all the physicians to report at once the cases of typhoid and of typhoid "suspects" seen by them within a few days. Within twelve hours, fifty cases were reported. There-



after additional cases were reported with alarming frequency, over thirty new cases being reported on December 15. At the direction and under the supervision of the State Board of Health, on December 12, free anti-typhoid vaccination was instituted, and on December 14 an emergency hypochlorite plant was installed. New cases ceased very abruptly after January 1, as can be noted by accompanying chart. An analysis of the total number of cases made January 20 by the city engineer's office, showed in all 334 authentically reported cases from November 1 to date. Six cases were

reported from this date to the 1st of February. Careful canvass of the local physicians added ten more previously overlooked, or a total of just 350 cases in all. It is believed that practically every authentic case during the period was reported.

The total number of deaths due to the epidemic were twenty-four; twenty-one deaths occurring locally and three in other localities.

Accepting the local estimate of population, 10,000, would give a morbidity percentage of exactly 3.5 of the entire population.

The mortality percentage of those attacked was 6.5, a rather low percentage considering the severe type of infection.

Epidemiological Evidence as to Etiology.

From the beginning the only etiological factors that could be suspected were water and milk. As soon as the State Board of Health was notified of the prevalence of typhoid, an investigation was begun of the cases already reported, with special reference to their source of milk and water supply. The City Health Officer had already correctly diagnosed the outbreak as probably due to a general infection of the water supply, cut off the bubbling fountains in the schools and on the streets, and published a general warning advising boiling of all drinking water. The milk supply was rigidly investigated by both the State Board of Health and the Dairy Division of the State Department of Agriculture. Although no evidence was at any time brought to light which pointed to milk infection, as a precautionary measure rigid regulations relative to delivery of milk to infected premises were enforced, and the state dairy inspector made weekly inspections of all the dairy plants. The thoroughness with which such precautions were carried out accounts for the fact that no case even remotely suggestive of milk infection occurred during the entire epidemic.

Investigation quickly showed beyond doubt that the public water supply was the single etiological factor. Experiments showed that under normal conditions there was a very free seepage from the stream bed to the large dug wells sunk in the river bank.

Corroborative evidence was furnished by the following:

(1) Proved existence of typhoid cases on the watershed earlier in the autumn. (At least four, possibly eight.)

(2) The periods of high water corresponding quite clearly to the onset of the epidemic, with proper allowance for incubation.

(3) The explosive character of the epidemic.

(4) The abrupt complete cessation of new cases following the installation of the hypochlorite plant, plus allowance for incubation period.

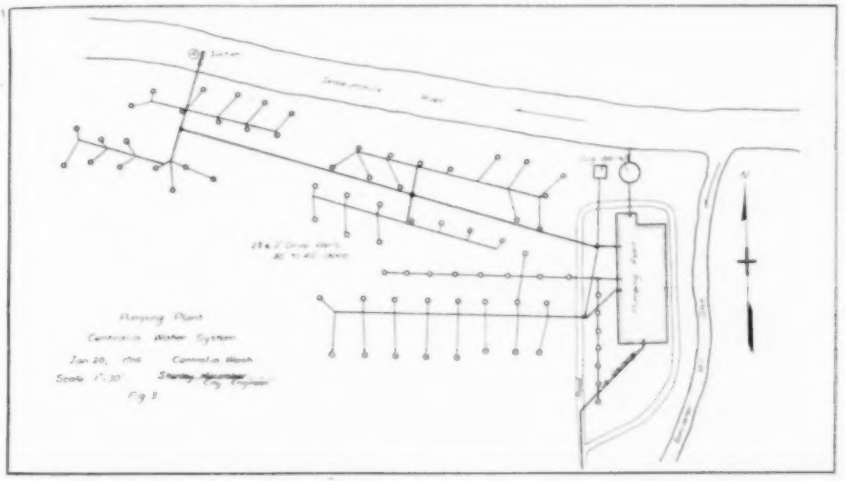
(5) The truly remarkable preponderance of cases in the portion of the city within the "water" district. Bearing in mind that a considerable proportion of the population, (possibly 25 per cent.) reside outside the

water district, that all the children of school age in the "non-watered" district drank city water at school, and that probably the greater part of the men living in the "non-watered" district used city water while at work, the

small number of cases developing in this district (14 out of 350) seems good evidence that "dosage" is a very important factor in water-borne typhoid.

The only other point of epidemiological interest as regards transmission is the question of secondary or contact cases.

There were four contact cases prior to January 7. Since this date corresponds to about the extreme limit of incubation following known complete sterilization of the drinking water, and also as there is direct evidence of contact in most of the cases occurring after this date, it is probably safe to consider all the cases reported from January 7 to March 5 as secondary cases. There are nine such cases. This would give a total of thirteen cases that should be classed as secondary or contact cases. There have been no cases since March 5—a period of three months.



Assuming all cases since January 7 to be contacts, the contact morbidity is low and must be attributed to the very thorough going preventive measures carried out during the epidemic.

Age and sex show no unusual features of distribution. Out of the total 350 cases, in thirty-four instances more than one case occurred in the same house. In six houses there were three cases; in two instances four cases in one house.

Organization to Combat Epidemic.

As soon as it was realized that the city was facing an epidemic, a temporary organization was effected to combat the disease.

The work accomplished naturally divides under two distinct headings—prevention and relief.

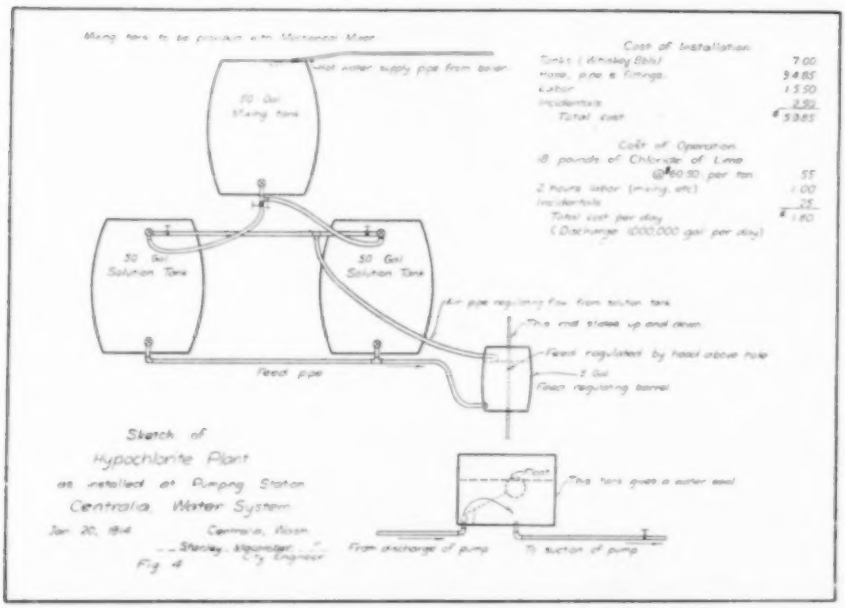
The preventive measures instituted were as follows:

(*a*) *Installation of Hypochlorite Plant.*

As soon as arrangements could possibly be made, a hypochlorite plant, designed by the State Board of Health's consulting sanitary engineer, was

installed at the pumping station (December 14, 1913). Some difficulty was experienced at first in so connecting it up as to keep air from entering the pumps. This was finally accomplished by making a water seal. The float regulates the flow of water into the tank and the suction pipe to the pump is regulated by a gate. The hypochlorite plant and the water seal have been working steadily ever since installation.

The tanks used were whiskey barrels and after a four months' run, new barrels were installed as the wood in the old ones was gradually being


Mixing tank to be provided with Mechanical Mixer
Hot water supply pipe from boiler
50 Gal Mixing Tank
50 Gal Solution Tank
50 Gal Solution Tank
Feed pipe
Air pipe regulating flow from solution tank
This end stands up and down
Feed regulated by head above hole
5 Gal Head regulating barrel
This tank gives a water seal
From discharge of pump
To suction of pump
Cost of Installation
Tanks (4 whiskey Bbls) 7.00
Hose, pipe & fittings 9.85
Labor 1.50
Incidentals .50
Total cost $ 5.85
Cost of Operation
18 pounds of Chloride of Lime @ $60.50 per ton .55
2 hours labor (mixing, etc) 1.00
Incidentals .25
Total cost per day $ 1.80
(Discharge 1000,000 gal per day)
Sketch of Hypochlorite Plant as installed at Pumping Station Centralia Water System
Jan. 20, 1914 Centralia, Wash.
Stanley Mylander City Engineer
Fig. 4

eaten out. The first dose given was 45 pounds of chloride of lime to 1,000,000 gallons of water consumed. This has gradually been decreased to a steady treatment of 18 pounds to the million gallons used. Bacteriological tests by the State Board of Health laboratory are made twice a week to keep track of the results. All hydrants, reservoirs, etc., were flushed to cleanse the system of contaminated water as soon as possible, but several days elapsed before this end was accomplished. Remembering that fourteen days is the average time of incubation for the typhoid germ, notice the direct results of the installation of the hypochlorite plant on the progression of the epidemic, as indicated by the accompanying chart. This plant was easily constructed at very reasonable first cost, about $60.00 not counting labor, and has been exceptionally efficient.

(b) Vaccination Against Typhoid.

Before the State Board of Health was even notified of the existence of a probable epidemic, many of the physicians of the city had begun immunizing with anti-typhoid vaccine.

A free typhoid vaccination clinic was inaugurated in the City Hall by the city government on December 12, four days after the first official notification to the State Board of Health. The State Board of Health laboratory prepared and furnished the vaccine. The city employed a nurse to assist the local and state health officials in administering the vaccine. After a few days the nurse was given complete charge of the work of vaccination, with volunteer lay assistants. The members of the city commission themselves rendered a great deal of assistance in this work. This free clinic was continued daily until February 1, although the last portion of January the clinic was transferred to the office of the county health officer and the services of the nurse dispensed with, as few inoculations were sought.

In all over 9,000 inoculations were given, a few less than 2,600 receiving all their inoculations, 500 took the first and second but did not take the third inoculation, and 342 individuals never returned after the first inoculation.

The physicians of the city report in addition 1,130 complete immunizations given in their practices of which record was kept, making a total of about 3,700 complete inoculations of record, or about 40 per cent. of the total population.

A number of cases developed typhoid following first inoculation—about fifteen in all, as nearly as can be determined. Five authentic cases of typhoid developed following the second administration, and three authentic and two doubtful cases several days after complete immunization. Two or three small painless sterile abscesses developed following inoculation. After careful investigation into this phenomenon the state bacteriologist concluded that this result was due to unusual individual susceptibility to the 0.4 per cent. tricresol used in preparingthe typhoid vaccine, and reduced the strength of the tricresol to 0.25 per cent. No complications of this nature have been reported since making this change. The United States hygienic laboratory strain of typhoid bacillus was used in making the vaccine. From careful observation of the course of the disease in those cases developing after partial inoculation, the local physicians say they are convinced that the inoculation received in the incubation period certainly did no harm and may perhaps have exerted a favorable effect upon the course of the disease.

(c) General Sanitary Measures.

As soon as time could be taken from relief work, a campaign for a general clean-up was inaugurated. This work was put in charge of the city engineer, and later the city commission by ordinance made that official the permanent sanitary official.

To obtain the best results the city was districted and a general survey made of conditions by the engineer's assistants. Notices were served on persons responsible for premises considered insanitary and arrangements made to remove all rubbish, etc. Metal fly-top garbage cans were ordered to take the place of all wooden garbage receptacles. All manure piles were ordered enclosed in fly-tight boxes. In the sewer district all places were ordered connected to the sanitary sewers, and open toilets completely abolished. Where no access to sanitary sewers could be had, open toilets were put in good condition and ordered treated with lime once a week. The aim was to make the city and the surrounding country as sanitary as possible. In furtherance of this work there have so far been recorded: 920 written notices sent out, 5,208 inspections made, 110 sewer connections, 106 open toilets abolished, 731 open toilets rebuilt. The sanitary condition of the city at present is fairly good but work will be continued along this line. It is believed that these measures have greatly tended to decrease the number of secondary cases incidental to an epidemic of this kind.

(d) Disinfection, Educational and Home Visiting Work.

As soon as the number of cases became so great that it was difficult for the local profession to even see all the cases, two nurses were employed by the city as visiting nurses, working under the immediate supervision of the county health officer. This arrangement proved a most excellent one. These nurses visited practically every case as soon as reported, regardless of social condition, leaving both verbal and printed disinfection instructions, reported cases which needed hospital care, filled in data that was missing on original case report, and, in several instances, learned of new cases and reported them to the city or county health officer for investigation and verification before they had been seen by any physician.

The sanitary inspector was kept almost continuously busy in placarding houses and (later) in removing placards. As far as possible he worked in conjunction with the visiting nurses. The placarding of houses is required by state law, but it also proved a very practical measure in other ways. It enabled the nurses to readily locate premises, thus saving much valuable time in cases of imperfect address, or where street numbers were lacking. It served as a very practical guide for the milk wagons, which were working under special regulations laid down by the state dairy division, thus enabling them at once to tell typhoid premises. Unquestionably, the mere presence of the warning placard served as a deterrent to

needless visiting, and, hence, helped to keep down the number of contacts, while the daily visits which the nurses made to those homes where there was especial need for close observation, removed the possibility of any families where there were sick, suffering from lack of visitors.

In addition the visiting nurses did a small amount of bedside nursing in some of the poorer homes, but experience quickly showed that removal to the emergency hospital was much superior to furnishing nursing care in the home, in houses where complete sanitary conveniences were lacking.

The local press throughout rendered valuable assistance, daily printing proper methods for precaution and advising typhoid vaccination.

Relief Measures.

There is remarkably little pauperism in Centralia, as little, perhaps, as can be found in any city of ten thousand population. But because the city is a railroad and lumbering and mining center, there is a very large floating population which, under normal conditions, is accommodated in rooming and boarding houses. This class of population in time of epidemic can only be satisfactorily cared for by hospitalization. From the standpoint of hospital accommodations the city is also unusually well equipped for its size, having in all over one hundred permanent hospital beds.

Yet it soon became evident that the local hospital facilities would be entirely inadequate, and the county board of health obtained permission from the governor and state adjutant general to convert the local militia armory into an emergency hospital. The governor ordered the hospital corps of the National Guard to proceed to the local armory on active duty. After the hospital had been opened a few days, arrangements were made whereby one of the surgeons of the hospital corps of the Guard remained as a resident physician at the emergency hospital throughout the epidemic, relieving a temporary interne, kindly placed at the services of the local authorities by the Seattle Emergency Hospital.

This assistance so courteously extended to the local authorities by the state military authorities was of great service and was the only financial assistance received from any outside source.

To the emergency hospital only those were admitted who could not have proper nursing and isolation elsewhere. All who entered the hospital were seriously, most of them dangerously, ill. Each patient remained under the charge of the attending physician recommending admission, supplemented by the constant supervision of the militia surgeon. Ample nursing care was provided for all patients admitted, the nursing staff being organized, and nursing, drug, diet, kitchen and general equipment being installed under the direct supervision of a lady residing in the city who had fortunately had previous experience as a nursing executive in emergency hospitals.

Through the courtesy of the local Commercial Club the secretary of that organization assumed and ably discharged the duties of business management of the emergency hospital throughout.

A Citizens' Volunteer Committee raised several hundred dollars for the purpose of supplying "extras" as special nurse care, additional comforts and delicacies for convalescents at hospital, etc.

The hospital was in use forty-five days. In all seventy patients were admitted, the average length of stay being twenty days. The total number of fatalities in the hospital were two. When the very grave nature of the illness of the average case admitted is taken into consideration the mortality record is very satisfactory.

Cost of the Epidemic.

To attempt to place a monetary estimate upon the loss produced by an epidemic is, in many respects, a superfluous task. No one will deny that the human loss that can never be reduced to dollars and cents outweighs all other considerations in calamities of this type. Nevertheless, the following figures may be of interest:

1. Direct Expenditures due to Epidemic.

State Board of Health general fund (about)	$500.00
City of Centralia	726.85
Lewis County	4,515.22
State Militia Fund	1,457.35
Total	$7,199.42

2. Estimate of Indirect Loss.

The statutes of several states place a monetary value on an individual life if killed by accident at $5,000. Several eminent authorities have agreed in fixing the figure of $100.00 as the minimum direct cost through loss of wages, sickness expense, etc., for the average case of typhoid at all ages. This figure is probably erroneous on the side of under-estimation for a community on the Pacific Coast. But accepting these two estimates, the indirect cost of lives sacrificed and sickness to the individual families in this outbreak is as follows:

24 lives at $5,000 each	$120,000.00
326 cases of illness at $100 each	32,600.00
Total	$152,600.00

In addition there is a heavy although undeterminable loss to any community from a typhoid epidemic, resulting from loss of trade, temporary depreciation of property, demoralization of local industries, etc.

Conclusions.

Certain striking features present themselves in relation to this epidemic which are sufficiently out of the ordinary to warrant calling particular attention to them. They are:

(a) Coincidence of practically complete cessation of new cases at the end of average incubation period, following the installation of the hypochlorite plant.

(b) Extent of vaccination proportionate to the total population and certain failures and complications of vaccination.

(c) Efficiency of the Emergency Hospital care and low Emergency Hospital mortality.

(d) The small number of secondary cases.

(e) The resulting sanitary improvement in the town.

And the general conclusion of the whole matter—the heavy price paid for the continued use of a known polluted water as a municipal supply without any purification or sterilization. In Centralia's case this apparent failure of municipal responsibility is possibly more excusable than in many similar instances, because the city had only obtained ownership of the water supply from a private corporation four months prior to the outbreak, and before the epidemic occurred had let the contract for the construction of pipe lines to an uncontaminated source twenty-five miles higher up on another stream, in uninhabited foothills lying within a patrolled Federal Forest Reserve.

REVIEW OF FORMALDEHYDE FUMIGATION.

WM. DREYFUS,
New York City.

Read before the Laboratory Section, American Public Health Association, Colorado Springs, September, 1913.

It is just about four years since I had the pleasure of reading a paper before this Section, on the Importance of Standard Methods for Testing Disinfectants, which resulted in the appointment of a Standardization Committee by the Council of this Association, the work of which has borne, as you all well know, such excellent fruits.

In taking a bird's-eye view of the various methods used in this country as well as abroad for room disinfection by means of formaldehyde, as a preventive or after cases of communicable diseases, the situation reveals conditions almost as chaotic as those of the testing of disinfectants did in 1909. Many investigators, however, have sounded the note of warning years ago, particularly Rickards, in a paper read before the Section of Medical Health Office, in 1908 and Holm and Gardner, in an article published in the *Journal of Infectious Diseases*, 1910. It is not within the scope of this paper to enter into the merits of formaldehyde disinfection in general or to discuss after which diseases it should be practiced, but there is no doubt that the lack of uniform methods of application under fixed conditions is responsible in a very great measure for the discredit into which disinfection has fallen with a large percentage of professional men.

The chemical and physical characteristics qualify formaldehyde as the most suitable agent today for disinfecting rooms and objects contained therein and a number of thoroughly scientific experiments as well as actual experience in practice prove that most reliable results can be obtained.

The respective literature on the subject offers an enormous field of suggestions, concerning methods and apparatus for room disinfection by means of formaldehyde and considering the great importance of the question, it may be of interest to review briefly the most common ones.

1. GENERATION OF FORMALDEHYDE GAS BY OXYDATION OF METHYL ALCOHOL.

This is probably the oldest method of production and consists of passing methyl alcohol vapor over heated platinum black or platinized asbestos by means of suitable contrivances. Their number counts legion and although they do not interest us from a large scale viewpoint on account of economy and efficiency, they still enjoy considerable application in homes, offices, etc., for deodorizing purposes and for medicinal uses to disseminate essen-

tial oils, menthol, thymol, etc. The chemical process of these lamps still forms the basis for the process of manufacture of formalin commercially today.

2. Generation of Formaldehyde Gas-Water Vapor Mixtures by Means of Apparatus.

This method is based on the principle of vaporizing the gas from an aqueous solution by means of external heat. The oldest representative type is the Trillat autoclave which, however, has almost gone out of use. In this country a certain type of regenerators still enjoys a great reputation on account of its efficiency, simplicity, economy, and safety from explosion. The formaldehyde solution drops by means of a needle-valve into a heated concave copper chamber, where it is immediately broken up into formaldehyde gas and water-vapor. It is well known that if formaldehyde solution passes over a surface heated above the degree of Depolymerization, say to about 200° C in a slow, steady stream, absolutely no polymerization can take place. In Germany the so-called "Glykoformalmethod" where glycerine is added to the formaldehyde solution, and other similar methods have been considerably used. The object seems to be to produce a spray or mist whereby a more uniform distribution of formaldehyde and water vapor is obtained in the space. The best of these apparatus have the great advantage that the yield of formaldehyde gas is very high and that they can be operated from the outside of the room to be disinfected and their action thereby controlled.

3. Formalin Sheet Spraying Method.

This method is based on the evaporation of a formalin solution from a sheet saturated with same. From a chemical standpoint I should doubt if this is a very economical mode of application, in as much as formalin by slow evaporation will polymerize a large percentage of formaldehyde into paraform.

4. Generation of Formaldehyde Gas and Water Vapor Mixtures without Special Apparatus.

The main characteristics of this method consists in the fact that no direct fuel supply is necessary to produce formaldehyde gas and water vapor, but the heat is supplied by chemical reaction between the formaldehyde solution and the other reagent, which is generally an oxydizer. The best known of them all is the formalin-permanganate method which is too well known to require further description except that various experimenters have adopted different proportions of permanganate and formalin in view of obtaining the highest percentage of gas. Evans recommends practically 4 to 10. Base and McClintic of the Hygienic Laboratory 5 to 10, The Bureau of Animal Industry 8 to 10, Hill & Roberts, Minnesota State Board of Health Laboratories, 7 to 10 per 1000 cubic feet. A prominent municipal Health officer told me about a year ago that he found the formaldehyde

permanganate method to give, even in dosage of 16 ounces of formaldehyde and 8 ounces of permanganate per thousand cubic feet, very unsatisfactory results, and that furthermore, the inspectors refused to use that method, complaining that their health is being affected through their fumigation work, because the reaction is so quick after sealing that they cannot leave the room quick enough and the formaldehyde vapors which they are compelled to inhale are very detrimental to their general well-being in the long run. He says they are compelled to consider the comfort of the inspectors and I thought it was a very important factor. Even from an economical viewpoint, this Municipal Health Officer assures me that although the formaldehyde-permanganate is cheap in cost of material, the process of disinfection by that method is more expensive, because they have to use a very large pail in which they place the ingredients, and the inspector has to call back for that pail after the premises are opened up, or abandon same, which in either case is a waste of labor and therefore an increased cost over the use of solidified preparations. Home and Gardner, in their very able investigation referred to at the beginning of the paper, prove that the lower the ratio between formaldehyde and permanganate the higher the loss in available formaldehyde gas and in order to insure abundance of moisture a permanganate diluted formalin can be used to great advantage, one of the best formulas being that of Hill and Roberts, namely:

Formaldehyde	11	parts by	volume
Permanganate	11	" "	weight
Water	9	" "	volume

Abroad, various investigators have experimented to replace permanganate with other oxydizing agents, such as barium, or strontiumperoxide, hypoclorides, etc., using paraform instead of formalin or formaldehyde source but they show less efficient and about doubly more expensive. More satisfactory results, however, were obtained by replacing a small percentage of permanganate with another oxydizer and the greatest hope for improvement over the present method comes from this quarter.

In spite of the great advantages in efficiency and simplicity, the question of economy and the discomfort and harm caused to those who have to work with it regularly, prevent to secure to the permanganate-formalin method the popularity it would otherwise deserve or enjoy.

There is still another group of Formaldehyde generators to be mentioned, the so-called commercial fumigators, which produce their gas either from solidified formaldehyde or by vaporizing paraform in various ways. Most of the manufacturers, however, fail to state the proper quantity required per 1,000 cubic feet and in most cases where statements are made they are exaggerated and unreliable, otherwise these so-called candles would enjoy great popularity on account of their simplicity. Holm says: "It is a curious

fact that the various proprietary manufacturers have in their possession testimonials and recommendations from numerous bacteriologists showing the efficiency of their products, and many of these bacteriologists are peculiarly men of national or international reputation. But the methods of investigation and the nature of the culture as well as the conditions of exposure vary so enormously that such testimonials are practically worthless. I know of a case where a prominent board of health using one of the best known brands is compelled to use the candle in four times the strength recommended by the manufacturer on the label."

Another point which needs mention is the want of accuracy in control tests which is most ably discussed by Dr. Hüne in "Desinfektion," Volumn 4, No. 1.

Rickards, after collecting his statistical information regarding disinfection as carried on in the larger cities of the United States, says: "The present situation is intolerable viewed from a scientific standpoint. If disinfection is of value in any case then it should be done in an efficient manner; a manner proved by exhaustive work to be reliable. If disinfection in general is not of value and can be proved to be of little or no value in any given disease, then disinfection in that case should be abandoned and trouble and expense thus saved."

When we consider these words, I think it is high time for this Section to take up this important question officially by asking the Council to appoint a standardization committee to investigate formaldehyde room disinfection.

UPON THE DETERMINATION OF MINUTE QUANTITIES OF NITRATES, PARTICULARLY IN POTABLE WATERS.

AUGUSTUS H. GILL,

Massachusetts Institute of Technology, Boston.

Read before the Laboratory Section of the American Public Health Association, Colorado Springs, September, 1913.

In a study of the determination of this substance made twenty years ago, the opinion was stated that advancement in its estimation was to be "sought not in the reduction to ammonia but in the formation of nitro bodies of high coloring power and constant composition."* The method there recommended consisted, as has been shown later,† in the formation of ammonium nitrophenol disulphonate from the reagent phenol disulphonic acid (1, 2, 4) and the estimation of the depth of the color. This will detect 0.001 part of nitrogen as nitric acid in 100,000, or one part in one hundred million. While engaged in this work, it occurred to the writer to compare the strengths of ammoniacal solutions of Martius' yellow (dinitro *a* napthol 1, 2, 4) and picric acid (trinitrophenol) which was supposed at that time to be the colored compound formed, each of the same nitrogen contents,—approximately 10 mgs. of it in 500 cubic centimeters; it was found that the former was ten to twelve times as deep in color as the picrate. Consequently, the formation of this body should enable us to obtain the next place or one part in one billion and afford the same delicacy to the nitrate as to the nitrite and ammonia tests.

It became a question of preparing *a* napthol disulphonic acid OH: SO_3: SO_3:: 1: 2: 4, which was stable and of sufficient purity as to yield a blank. Preliminary experiments were made with pure *a* napthol and sulphuric acid, the colors obtained with the nitrates were deep—and so were the blanks. The napthol was then distilled four times in an atmosphere of carbon dioxide—for it seemed to turn brown by oxidation—yielding a beautiful snow white product: the sulphuric acid was the purest obtainable the so-called "Kjeldahl acid," carefully redistilled in the laboratory. Upon heating together 8 grams of the napthol with 150 grams of the 93 per cent. acid at 50° for three hours an acid was obtained which in an 8 per cent. solution in sulphuric acid gave a good color with .002 parts per million. This, on standing twenty-four hours, lost its power, and all acids made with a weak sulphuric acid showed the same defect and also an inferiority of color. The acids so prepared had the advantage of being practically colorless,

*J. Am. Chem. Soc., *16*, 122 and 197 (1894).

†Chamot, and Pratt, id. *31*, 922, and *32*, 630.

which was not the case with those obtained with the strong acid. These were probably mixtures of 1, 2, and 1.4 mono sulphonic acids.

An acid was next prepared by warming the napthol with double its weight of strong sulphuric acid and when solution was complete adding its weight of distilled fuming acid making a 25 per cent. mixture of napthol in fuming sulphuric acid, the sulphonic acid not being completely soluble. This gave a distinct yellow with .001 part of N per million but the blank had a faint greenish tinge; similar results were obtained with a solution half as strong. While this solution would seem sufficiently delicate yet it is deficient in keeping power.

The lead and calcium salts were prepared from the latter acid, washed with water free from ammonia until a blank was obtained and the acid freed by sulphuric acid; this solution gave a distinct color with .001 part of it and a blank; in a week's time, however, blanks could not be obtained.

The barium salt was next tried: the *a* napthol was distilled four times in a stream of carbonic acid and treated with five times its weight of carefully redistilled sulphuric acid containing 20 per cent. anhydride, for two hours on the water bath. It was next neutralized with barium carbonate, the air expelled from the solution with carbonic acid and allowed to stand. The barium *a* napthol disulphonate formed was washed with water and recrystallized from water free from ammonia.

Portions as large as three pin heads were put into the dish containing the nitrate residues and rubbed up with the purest sulphuric acid. A good yellow was obtained with .001 part per million. The reagent, however, in a week's time became inactive.

Similar results were obtained by the use of a purified disulphonate made from that commercially obtainable. This same was found to be true of the acid made according to the procedure of Conrad and Fischer, Annalen *273*, 105 (1893)—the *a* napthol disulphonic acid 1, 2, 4.

There will be no difficulty in estimating nitrates in potable waters to one part in one billion if a suitable and permanent napthol sulphonic acid can be obtained.

The writer wishes to express his obligation to Messrs. Weston, Pugh, Tufts, Newton and Miss Thomson by whom the experimental work has been performed.

THE INHIBITING ACTION OF A COLORED WELL WATER ON BACTERIA AND A STUDY OF THE INHIBITING EFFECT OF SOME INORGANIC SALTS.

E. J. TULLY,

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Read before the Laboratory Section, American Public Health Association, Colorado Springs, September, 1913.

Occasionally, in connection with the regular routine work of the laboratory, samples of well waters have been received which proved to be practically sterile when subjected to a bacteriological examination, and, therefore, apparently of satisfactory quality, but from a chemical viewpoint some of these waters did not appear to be entirely acceptable. The results of analysis in one particular case indicated the presence of relatively large amounts of nitrogenous organic material, and comparatively a very large amount of iron. A considerable quantity of the iron was in solution and the turbidity was mainly due to iron. It was thought that some interesting results might be obtained by subjecting different bacteria to the action of this water, and at the suggestion of Dr. M. P. Ravenel, director of the state laboratory of hygiene, the experimental work was extended to include a few pathogenic organisms.

In order to eliminate the few organisms found in relatively large quantities of the water (5 cc.), a large sample was placed in a sterile Erlenmeyer flask, plugged with cotton, and slowly brought up to a temperature of 80° C. After a few minutes' exposure to this temperature the flask was allowed to cool at room temperature; and, when cool, 100 cc. samples were measured with a sterile graduate and placed in sterile Erlenmeyer flasks having a capacity of 150 cc. The water was heated to 80° rather than sterilized under pressure in order to prevent the precipitation of bicarbonates and iron, and thus ensure the original salinity of the water.

The organisms selected were B. coli, B. typhi, B. disinteriæ, a streptococcus, a staphylococcus pyogenes aureus, B. cholera suis, B. diphtheriæ, B. pyocyaneus, B. prodigiosus and B. lactis ærogenes; and, after pure cultures had been obtained on lactose agar, suspensions of these organisms in sterile distilled water were made. The distilled water was obtained by distilling lake water acidified with concentrated sulphuric acid in glass stills and was entirely free from salts and organic material. Each one of the sterile 100 cc. samples of the well water was inoculated with one of the organisms and, after the flasks were well shaken, the bacterial content of each one, with

the exception of the flask containing B. dipthheria, was determined by plating a dilution of 1 cc. of the sample in agar, and incubating the plates at 37.5° C. The bacterial content of the flask containing the diphtheria bacilli was determined approximately by comparing its turbidity with the other suspensions. A series of controls were also made by inoculating flasks containing 100 cc. of sterile distilled water, to which had been added a small quantity of inorganic salts necessary for growth, with one cubic centimeter of a suspension of the respective organisms.

The flasks were kept at room temperature for twenty-four hours, when the bacterial content of each was determined by plating one cubic centimeter in lactose agar, and after an incubation period of twenty-four hours at body temperature the plates were counted. The viability of the diphtheria

TABLE I.

EFFECT OF WELL WATER ON LONGEVITY OF ORGANISMS EXPOSED FOR TWENTY-FOUR HOURS AT 20° C.

Number of organisms present in 1 cc.

Samples.	Organisms exposed to well water.					
	B. coli.	B. typhi.	B. dysent.	Staphylococcus.	Streptococcus.	B. diphtheriae.
Initial number of organisms present in 1 cc. of inoculated well water..	58,000	120,000	1,000,000	6,520,000	6,500,000	6,500,000 (approx.)
Number of organisms present in 1 cc. of well water after 24 hours...	4,900	700	2,120	9,740	15,250	0
Number of organisms present in 1 cc. of controls after 24 hours' exposure.....	47,000	31,000	671,000	502,000	415,000	+

+ = present.

organisms was determined by centrifugating 10 cc. of the sample in sterile tubes and smearing the sediment on blood serum slants by means of a sterile platinum loop. The slants were incubated at 37.5° C. In the case of the control, growth resulted, and a portion of the growth appearing on the blood serum after an incubation period of twenty-four hours at 37.5° C. was smeared on a glass slide, stained with methylene blue and examined microscopically for the purpose of confirming the growth on blood serum, which appeared typical; the organisms showed microscopically all the morphological characteristics of B. diphtheriæ. The effect of this twenty-

four hour period of exposure of the organisms to the water was quite interesting. The results indicate that a material reduction in the number of organisms present in each flask took place during this period, and show that some of the bacteria possessed a relatively higher power of resistance to the toxic influence of the well water than others. The results of the test after one day's expose of the organisms to the water are given in Table I.

TABLE II.

EFFECT OF WELL WATER ON LONGEVITY OF ORGANISMS EXPOSED FOR TWENTY-FOUR HOURS AT 20° C.

Samples.	Organisms exposed to well water.					
	B. coli.	B. typhi.	B. dysent.	Staphylococcus.	Streptococcus.	B. diphtheriæ.
	Number present in 1 cc. after 48 hours.					
Initial number of organisms present in 1 cc....	58,000	120,000	1,000,000	6,520,000	6,500,000	6,000,000 (approx.)
Number present in 1 cc. after 24 hours' exposure at 20° C.....	671	64	199	850	1,360	0
Number present in 1 cc. of contents after 24 hours' exposure at 20° C.....	96,000	5,000	486,000	750,000	1,310,000	
	Number present in 1 cc. after 72 hours.					
Initial number of organisms present in 1 cc. ..	58,000	120,000	100,000	6,520,000	6,500,000	6,000,000 (approx.)
Number present in 1 cc. after 24 hours' exposure at 20° C.....	81	0	28	166	190	0
Number present in 1 cc. of contents after 24 hours' exposure at 20° C.....	30,000	1,040	670,000	370,000	900,000	

The decline in the number of organisms in each flask during the day was quite marked. In order to note the relative rate of decline of the different bacteria over a longer period, the flasks were again incubated at 20° C., and after forty-eight and seventy-two hours' exposures respectively, quantitative determinations of the numbers of the respective organisms were made. The same procedures mentioned above in regard to plating and cultivation were followed each time. The results are tabulated in Table II.

These results indicate quite conclusively that the inhibiting action was due to the material present in the water. It appears that the toxic action of the water was sufficient to destroy most of the organisms present in the flasks in three days; and, as the quantity of ferruginous material present in the water was quite large, the presumption was that the marked diminution was probably due to the inhibiting influence of the iron.

Having determined the effect of the sterile well water on the longevity of the different organisms in pure cultures, attention was next directed to the question of the influence of some of the common inorganic salts in different concentrations on the viability of the respective organisms. For the purpose of ascertaining the relative efficiencies of the elements and radicles as inhibiting or antiseptic agents and, also, in order to determine the correctness of the supposition that the iron had something to do with inhibiting the growth of the organisms in the well water, magnesium sulphate, sodium sulphate, calcium chloride, magnesium chloride, ferrous sulphate, ferric chloride, and potassium nitrate were selected and comparatively weak and concentrated solutions of each salt were made for the experimental work.

The solutions of the salts were made in sterile distilled (in glass) water and varied in concentration from 10 per cent. to .005 per cent.; and to each series of flasks containing one of the salts one cubic centimeter of a suspension of the respective organisms in sterile distilled (in glass) water was added.

After an exposure of the respective organisms to the salts for twenty-four hours, quantitative determinations were made by plating one cubic centimeter of the inoculated salt solutions in lactose agar and incubating at 37.5° C. for one day. In Table III the effect on the organisms of the salts in relatively concentrated and weak solutions are shown.

It would appear from these tests, in which various chemical solutions of a different nature were employed for the purpose of determining the action of the radicles, that the sulphate, chlorine and nitrate radicles and the elements, even in comparatively concentrated solutions, with the exception of iron, have relatively but little inhibiting action. The results, however, indicate that iron exerted to a certain extent a detrimental influence on the viability of the organisms.

A comparison of the results tabulated in Tables I, II and III, would appear to confirm the supposition that the high iron content of the water was influential in maintaining the low bacterial content.

Incidentally, this particular case exemplifies the desirability of making a sanitary chemical as well as a bacteriological examination of a sample of water. The bacteriological data in this particular instance, while indicating that the water was safe, in so far as low bacterial counts may be regarded as satisfactory evidence of good quality, do not afford any infor-

mation whatsoever in regard to the antecedent history of the water. The sanitary chemical analysis, however, gave desirable information in regard to the general quality of the water and the character of the soil from which

TABLE III.

THE EFFECT OF DIFFERENT CONCENTRATIONS OF THE INORGANIC SALTS ON SOME ORGANISMS.

Samples.		Organisms exposed to salt solutions.					
		B. coli.	B. typhi.	B. dysent.	B. lac. ærog.	Strepto-coccus.	Staphylo-coccus.
Initial number of organisms present in 1 cc. of salt solution.....		300,000	280,000	30,000	50,000	960,000	30,000
Number of organisms present in 1 cc. after 24 hours.....		310,000	90,000	21,200	42,000	600,000	36,000
Sols. of Salts.		Number of Organisms present in 1 cc. after 24 hours' exposure.					
$MgSO_4$	10. %	50,000	40,000	9,000	1,500	180,000	15,000
	0.01 %	240,000	71,000	28,000	37,000	410,000	40,000
Na_2SO_4	10. %	70,000	55,000	10,100	11,000	210,000	8,000
	0.01 %	205,000	86,000	18,000	65,000	715,000	40,000
KNO_3	10. %	72,000	3,600	5,100	12,500	50,000	300
	0.01 %	184,000	47,500	27,000	75,000	411,000	46,000
$MgCl_2$	10. %	1,500	9,000	8,000	2,000	150,000	12,000
	0.01 %	140,000	65,000	17,800	50,000	480,000	80,000
$CaCl_2$	10. %	0	0	0	0	1,200	150
	0.01 %	78,000	16,000	11,000	33,000	302,000	20,700
$FeSO_4$	0.01 %	33	0	0	60	58	88
	0.005%	140	2	18	270	360	304
$FeCl_3$	0.01 %	18	0	0	29	61	108
	0.005%	97	1	20	215	200	275
$FeSO_4$ ± Na_2CO_3	(a) 0.005%	270	6	35	270	266	410
$FeCl_3$ ± Na_2CO_3	(a) 0.005%	194	4	27	310	260	380

(a) Theoretical amount of Na_2CO_3 to combine with sulphate and chlorine radicles respectively.

the water was derived or through which it passed: the results of the chemical determinations indicated that the water could not be regarded as entirely acceptable, although the bacteriological data indicated a satisfactory supply.

THE REFERENDUM FOR THE WINNEBAGO COUNTY TUBERCULOSIS HOSPITAL.

OTTO F. BRADLEY.

Read before the Sociological Section, American Public Health Association, Colorado Springs, September, 1913.

Any measure entailing a substantial expenditure of public funds has but a meagre chance of carrying when referred to a vote of the people. If the referendum happens to be in a rural community, where opposing taxation, the farmer's greatest bugbear, is almost a religion, even the small chance is eliminated. Its defeat is almost a certainty.

It was, therefore, unusual that the voters in a Wisconsin County, with a population one-third rural, recently voted an appropriation for a tuberculosis sanatorium by a large majority. The campaign responsible for this action should interest those concerned with public education.

To be complete the story of this campaign would have to go back to the first organized public health education in Wisconsin. It would describe the program of lectures, literature, exhibits and education through the newspapers; work with the general public and in the schools; and special campaigns for the cities and the rural sections; all of which have been a part of the comprehensive scheme of the Wisconsin Anti-Tuberculosis Association for securing general popular enlightenment on this subject. The increased understanding along these lines has not only resulted in better private living conditions, but has made possible the introduction of special projects dependent upon public support.

An account of the pioneer educational work throughout the entire state, as well as in Winnebago County, belongs to the story of this project. It was only made possible by state subvention, which aid was secured by state-wide effort. The state pays $5 per week per indigent patient to county sanatoria in Wisconsin. The writer will only attempt, however, to outline briefly the recent county campaign.

The question of an appropriation for a sanatorium had to first be presented to the county board of supervisors. A general campaign was made, including public talks and the distributing of special literature throughout the county. The purpose of this was primarily to discourage the claim that the taxpayers would not favor it. In addition to the general work, a lobbyist from the Wisconsin Anti-Tuberculosis Association called on each member of the board personally. The result was an appropriation of $30,000 for the establishment of an institution, carried by a majority of but one vote.

Though it was afterward stated that several of the unfavorable votes resulted from a misunderstanding regarding the possibilities of securing a proper site, there was a strong sentiment, largely on the part of rural members, against making the appropriation.

Backed up by the ostensible fairness of their proposition that, since the sentiment of the board was so evenly divided and there was a difference of opinion as to the wishes of the majority of the taxpayers, it would be only fair to let the people decide the matter, the leaders of the opposition circulated petitions which were signed by the necessary 20 per cent. of the voters, putting the measure to a referendum vote.

Though the popular educational work had been fairly thorough, it was doubtful whether the majority of the taxpayers were in favor of an appropriation. The matter was to come up at a spring election, when there would be a very light vote in the cities and a heavy vote in the country. It, therefore, seemed certain that, unless something effective could be done, the sanatorium project was doomed.

For a long time county board members had shifted the responsibility of opposing appropriations to the alleged wishes of their constituents. It would be disastrous in other counties to have an example of the people declaring against such an appropriation. The establishment of more than one institution was, therefore, at stake. Appreciating the importance of this election, a campaign was planned, with many doubts, but with more determination, which resulted in the decisive victory for the sanatorium.

It was generally felt that the people would not uphold the appropriation and the opposition did not feel it necessary to make a systematic campaign. In order to avoid arousing them to activity, nothing was done openly in behalf of the sanatorium until four days before election. The newspapers published stories from time to time of cases which illustrated the need of segregation, but the impression was never given out that a campaign was being waged.

An organization for getting out the stay-at-home voters in the cities was quietly effected and individual work was carried on in the different wards, however. The Trades and Labor Council of Oshkosh, the largest city in the county, made a discussion of this issue part of the regular order of business for every labor union at each meeting until election. A well-informed speaker was always present to direct the discussion along the right lines. Similar work was done among the unions in Neenah and Menasha, and letters were sent to practically all of the organizations in the county soliciting their support.

Four days before election, a sensational campaign was launched. All effort was directed toward bringing out the vote in the cities. The Metropolitan Life Insurance Company sent circulars to their 6,000 policy holders and over 2,000 other circulars were personally distributed in the

mills at Neenah and Menasha. The night before election, the boy scouts distributed 5,000 hand bills which they furnished themselves. In addition to the appeal to the voters, these dodgers stated that they were paid for and circulated by the boy scouts in the interest of humanity.

Much good work was done through the schools. By order of the county superintendent, the question was debated in all the schools through the county. Those wanting a sanatorium had confidence that it would profit by any fair discussion. When the debate was announced the children were given as much information as possible which they took home with them along with their questions, which at least aroused an inquiring interest on the part of the parents.

The Sunday before election "Sanatorium Sunday" was observed by the churches. Members of the various congregations were urged, not only to vote, but to join in the effort to get all the voters to go to the polls and cast their ballot for the sanatorium. The newspapers gave much space, publishing stories of the campaign. A resolution, signed by all of the election candidates, as well as proclamations from the mayors of Neenah and Menasha, was given broad publicity.

The result was a majority of 1,261 votes, or about three to two. The results of the general work that had been done in the rural sections previous to the special campaign were evident, but the majority of the votes cast in the country districts were against the appropriation. They were more than offset, however, by the large majority obtained in the three cities. The unusually large vote polled at this off year spring election was the subject of newspaper comment, which attributed it to the interest in the sanatorium issue.

A committee has been appointed which has prepared plans and, although there is a temporary delay on account of the site, they are pushing the sanatorium to completion as rapidly as possible. The leader of the opposition, who started the referendum, was made a member of the special committee. It is interesting to note that he is now one of the most enthusiastic pushers of the sanatorium in Winnebago County. The referendum convinced him that the majority wanted it and he quit opposing the appropriation. Later, when, as a member of the committee, he visited other institutions, he became enthusiastically in favor of it. After going through the Milwaukee institutions he declared his intention of returning home and starting, on his own accord, an educational campaign to popularize the sanatorium in the country districts.

CREATING A MUNICIPAL TUBERCULOSIS SANITARIUM BY REFERENDUM.

FRANK E. WING,

General Superintendent, Chicago Municipal Tuberculosis Sanitarium.

Read before the Sociological Section, American Public Health Association, Colorado Springs, September, 1913.

In March, 1909, the directors of the Chicago Tuberculosis Institute found themselves in a position to create an institutional provision for consumptives in Chicago through the enactment by the state legislature of what is known as the Illinois "Public Tuberculosis Sanitarium Law," an enabling act permitting cities and villages to establish and maintain tuberculosis sanitariums. The law becomes effective in cities and villages after a successful local referendum vote, and provides that the city council or board of trustees of such city or village, as the case may be, shall annually thereafter levy a special tax of not to exceed one mill on every dollar of assessed valuation for the construction and maintenance of said institution. A majority of those voting on the proposition is sufficient to carry the measure at a local referendum.

A one-mill levy in Chicago at the 1910 valuation would be $856,000. Such was the yearly amount which the Chicago electorate had within their power to authorize for the relief of 15,000 consumptives in need of institutional care, a dramatic background to the arena on which the fight for votes was to be waged.

The reasons for carrying on an extensive campaign were two:

First: Because the situation demanded not merely a favorable vote, however small, on the proposition, but such a big vote that there could be no doubt in the minds of the City Council, who were to levy the tax, as to where the people of Chicago stood in the matter of public care of the consumptive.

Second: The campaign offered an excellent opportunity for educational work.

With only a month intervening in which to make the fight, the board of directors of the institute at an early meeting formulated a comprehensive plan of campaign. This plan was carried out almost to the letter.

The campaign naturally divided itself into two important lines of activity —"endorsement" and "publicity."

Endorsement. In order to carry weight at the polls, it was recognized that a measure of this kind would require very wide endorsement. Efforts were at once directed to this end and with invariably good results. The commissioner of health and, as a natural consequence, all those connected

with the health department, became at once among the strongest and most influential supporters of the measure.

The vote was taken in connection with a regular aldermanic election, and as the measure was non-partisan in character, every aldermanic candidate of all parties, together with candidates for the office of city treasurer and city clerk, were asked to subscribe to it. The response was quite general.

The Chicago Federation of Labor passed resolutions of endorsement including a recommendation that each of the 200 delegates secure the endorsement of his respective local. Simultaneously with this action a letter was sent to the secretary of every local with a suggested form of resolution enclosed. These were acted on and returned by nearly forty locals.

In like manner philanthropic societies, settlements, civic bodies, fraternal organizations, women's clubs, the Chicago Medical Society and many other organizations not only endorsed the measure but sent letters to their members asking for votes.

Publicity. Of more practical importance than endorsement was publicity. In this the methods of the press agent and the advertising man were brought successfully into play. The Chicago newspapers supported the measure as a unit. During the entire campaign not a single news item or editorial appeared against the proposition, while many of the big Chicago dailies lent the full strength of their editorial and news columns to its support. One paper gave numerous signed articles by prominent physicians, together with a most effective cartoon on the day before election. The *Bulletin of the Chicago Medical Society* printed a letter signed by the president and members of the executive committee of the Tuberculosis Institute. In one issue the *Union Labor Advocate* gave ten full pages with illustrations; the Jewish papers gave editorials; the Italian papers used a letter signed by six prominent Italian physicians. Just before election bulletins were sent to the German, Swedish, Bohemian and Polish papers, and were used by them. Clippings actually gathered from the Chicago papers during the month's campaign measured 1,867 inches, or 155½ feet of column space. In addition to this, the *Bulletin of the Chicago Health Department* devoted practically all of its space for three weeks in support of the measure.

Another form of publicity was secured through public meetings. Speakers were provided by the institute at all of these meetings, including a large Jewish mass meeting, meetings before church clubs, civic bodies, and campaign meetings of all parties in the various wards.

Further publicity was secured by means of large two color "Mr. Voter" posters, as they were called. These were printed in different languages and distributed in every precinct as well as in the downtown district.

In addition to this, one hundred thousand four-page "Mr. Voter" folders

were printed, bearing on the front a duplicate of the poster, and on the inside pages the essential features of the law; also the results of treatment at the Edward Sanatorium at Naperville, proving conclusively that consumptives can be cured in Illinois, and on the back page a group photograph showing patients under treatment at Naperville, one of whom had gained twenty-seven pounds in seven months, asking the question, "Does this group suggest a failure?" and following with the further suggestion in color, "The Tuberculosis Sanitarium Law Has Opened the Door of Hope to Every Wage-earner in Illinois."

These were distributed in every way possible that would insure their going home to the voter—in employees' pay envelopes, by 600 agents of the Metropolitan Insurance Company, who distributed 40,000 folders, in aldermanic campaign literature, at settlements, clubs, etc., and by individuals.

Then the church was brought into the campaign. Speakers were sent to the down-town ministers' meetings of the various denominations. Six hundred letters, containing suggestions for an insert in the church calendar on the Sunday before election, were sent to as many ministers and special mention was made of the proposition from scores of pulpits.

The final stroke in the campaign was the mailing of ten thousand letters with the "Mr. Voter" folder enclosed—one to each of the five judges and clerks of election in 1,360 precincts, and one to each precinct committee man of both parties, asking them to vote "yes" on the measure and to use their influence in persuading others to do the same.

And with what result? There was some silent but no open opposition, presumably on the part of small property owners who would object to any measure involving a slight increase in taxation. When the returns were counted, it was found that the vote stood *167,000* "*for*" and *39,000* "*against*" the proposition. Five out of every six who voted the regular ballot, voted also on the special ballot; and four out of every five who cast the special ballot did so in favor of the measure. Such an overwhelming majority could not fail to have the desired effect on the city council when it became necessary to levy the first tax.

Subsequent events. Such are the details of the campaign which resulted in the creation of the Chicago Municipal Tuberculosis Sanitarium, thereby making possible an annual additional revenue of nearly one million dollars for a single phase of public health work. The remainder of this paper will outline briefly the steps which have been taken to carry the referendum decision into effect.

Within two weeks the mayor appointed a board of directors,* consisting

* Dr. Evans was succeeded by Dr. George B. Young, Health Commissioner, in May, 1911; and Mr. Higinbotham was succeeded by Mr. W. A. Wicboldt in May, 1913. The present officers of the board are Dr. Theodore B. Sachs, president, and Dr. George B. Young, secretary.

of Mr. Harlow N. Higinbotham, Dr. Theodore B. Sachs, and Dr. William A. Evans, three men already long identified with the anti-tuberculosis movement in Chicago, thereby assuring a high standard of administration of the newly created institution.

In January, 1910, at the request of the board, the city council included in its tax-levying ordinance an appropriation of $407,000 (one-half mill) for the purchase of land and beginning of construction, the same being available in 1911. The amounts available from subsequent levies have been $268,857 (three tenths mill) and $902,832 (one mill) for 1912 and 1913, respectively, while the amount available in 1914 (one mill) will be approximately $907,200, in all about two and one half million dollars in four years.

By sale of anticipation tax warrants sufficient money was realized to begin work in September, 1910, and at that time the board took over the entire dispensary work of the Chicago Tuberculosis Institute to become the nucleus of a city-wide dispensary system, which now comprises ten free tuberculosis dispensaries, with a staff of forty-five dispensary physicians, thirty-four of whom are a part of the paid service, one bacteriologist, thirty-seven nurses and the necessary clerical force.

Early in 1911 a site containing 160 acres was purchased, and Dr. Theodore B. Sachs was delegated by the board of directors to have charge of the preparation of plans. This work has been carried on energetically with the result that ground was broken late in 1911 and since the early part of 1912 construction has proceeded rapidly. Twenty-five buildings are now nearly completed and with the completion in 1914 of the large infirmary building now under construction, the institution will be ready for opening. The initial capacity will be 600 patients with an administrative capacity for handling 950 patients, to which number the facilities of the institution will be increased as soon as funds will permit, thus completing the largest sanitarium ever undertaken by any municipality in America.

THE SEATTLE REFERENDUM APPROPRIATING $125,000 FOR A MUNICIPAL SANITARIUM.

JOHN WEINZIRL, PH.D.,

Professor of Bacteriology, University of Washington, and Secretary of Washington Association for the Relief and Prevention of Tuberculosis.

Read before the Sociological Section, American Public Health Association, Colorado Springs, September, 1913.

The referendum is comparatively a new piece of legislative machinery in America and the instances of its use in obtaining appropriations for health work are so few and novel that it appears worth while to describe a campaign of this sort. The Seattle referendum, appropriating $125,000 for a municipal sanitarium, received such a sweeping majority as to make the conditions surrounding the campaign worthy of record; and it also suggests the question whether this mode of obtaining funds for health work might not be more widely employed with advantage.

The Seattle referendum occurred March 5, 1912. It was one of seven propositions submitted and one of four appropriating money for municipal purposes. It was the seventh proposition submitted and friends in the council advised its postponement, believing that it could not carry along with what appeared to be an already excessive budget. The fact that this proposition carried by the largest majority and the lowest negative vote, not only of the seven propositions but also of the twenty-seven charter amendments submitted at the same time, renders it a notable victory for health work and one never to be forgotten among anti-tuberculosis workers. The vote in favor was 39,014, and against, 8,831, thus giving 81.5 per cent. of the votes cast in its favor. The only other vote which approached it in unanimity was on an insignificant charter amendment (No. 9), providing for yearly examinations of city accounts, with 35,333 for, and 7,145 against. In this connection it may be worth while to list the propositions submitted, together with the vote cast.

The vote on the several propositions is interesting from several points of view; in this connection, it is especially interesting because it shows the discrimination *exercised* by the voters. The citizens voted for the sanitarium because they believed it to be a good thing. At this election women voted for the first time in our city and this undoubtedly favored the sanitarium.

PROPOSITIONS SUBMITTED MARCH 5, 1912.

		Amount.	For.	Against.
1	For acquiring a municipal telephone	0	32,498	18,163
2	For adoption of Bogue plan for a civic center	0	14,406	24,966
3	For granting street railway extensions	0	16,785	22,924
4	For parks and park development	$500,000	30,047	15,370
5	For purchase of Lake Cushman power site	500,000	25,446	20,161
6	For purchase of White River power site	1,000,000	27,067	17,223
7	For erection of municipal sanitarium	125,000	39,014	8,831
8	Also eight harbor improvement propositions (By special port election held same day)	8,100,000	Carried	

METHODS EMPLOYED TO BRING ISSUE BEFORE VOTERS.

A. *Immediate Means.* The immediate means employed to bring the issue to the attention of the voters were few. On January 20, 1912, the executive committee of the King County Anti-Tuberculosis league unanimously voted to request the city council to submit to the voters of Seattle a proposition to bond the city for $125,000 for the purpose of erecting and maintaining a municipal sanitarium. They agreed to deed to the city, if the vote should carry, the site and property of the league, consisting of 34.4 acres, temporary structures and equipment accommodating, at the time, forty-two patients. The site was well located and conveniently situated on an interurban line just outside of the city limits. It was held at $1,000 per acre by the owner. The other property had cost the league $16,548.63.

The executive committee making this request of the council was composed of a remarkable group of men, viz., F. W. Baker, D. E. Frederick, A. S. Kerry, F. S. Stimson and J. F. Douglas, with H. C. Henry as president. These had been selected by Mr. Henry some months before from the most eminent and successful business men of the city, as his advisers in managing the sanitarium. This fact is here recorded as throwing an important light upon the question submitted. The request was backed by earnest men, matured in business experience and well known to the community. The confidence inspired by this committee would probably have been sufficient to carry the measure, but it was deemed advisable to employ some publicity measures.

Among the publicity measures was the securing of the coöperation of the city newspapers, all of which gave freely of their space and this no doubt commanded the attention of more voters than any other one factor. Another factor of immense value was the posters printed by the Pioneer Printing Company, and displayed by Foster and Klesier on their bill boards, both free of charge. Most novel among the measures was the work of the boy scouts, who on Saturday before the election distributed a manilla

card circular, 4½ by 11 inches, at the door of every residence in Seattle; in most instances the circular was placed over the door-knob to insure its being seen. This circular gave the facts concerning tuberculosis in Seattle, and made a thrilling appeal to the voters. A return detachable post card requested contributions to the King County Sanitarium, the psychological inference being "if you do not vote for the bonds, you must help support the sanitarium." The result of the campaign was a surprise to the most sanguine.

It would not do to close this statement without giving the customary sworn statement of election expenses.

ELECTION EXPENSES.

For posting placards,	$14.25
car tickets	1.31
hammer and tacks	.45
messenger service	2.15
polling list	.15
prizes to boy scouts	2.50
	$20.81

B. *Remote Factors.* To ascribe the success of this campaign to the immediate factors only would be committing a grave blunder and lead to an entirely mistaken view. Such a result is not obtained even in the far west without a considerable period of public education. To give an adequate idea of these remote factors would mean to give a complete history of the Anti-Tuberculosis League and other public health agencies. This is impossible except in merest outline and the reader is necessarily left to imagine the details.

The league was organized February 1, 1909, and in March Mr. William K. McKibbin was made executive secretary. Possessing a wide experience in ministerial, missionary and charitable work, he rendered the league most efficient services. A preliminary survey demonstrated the need for sanitarium accommodations for patients and for visiting and other nurses. A button-day campaign December 18, 1909, netted over $6,000 and afforded most valuable advertising. This was a whirlwind campaign managed by Miss Bethesda I. Beals, the efficient executive secretary of our present State Anti-Tuberculosis Association. Through the generosity of Mr. Allen Dale, a cafeteria campaign, which included the same date, netted $1,000. In June, 1910, a mammoth health exhibit accompanied by a program covering a whole week was held under the auspices of the state and city health departments and the league. This was an educational campaign and afforded most valuable publicity. A considerable number of paid member-

ships were secured by the league during the campaign. But the money thus obtained was only a fraction of what was needed in providing for sufferers. An appeal for aid was made to both the city council and the county commissioners. The county responded by a monthly contribution of $333.33 and later the city gave a like amount. Yet with all the sources of income, it became apparent within the next year that even subsidized charity would be unable to carry the lead but a short time. The necessity of the work had been established; the tremendous burden placed upon charity was equally plain; and the insufficiency of the public aid was pitiable. The result was the making of the appeal to the voters through the referendum provided by charter. The result of the appeal is now precious history.

There remains only a statement as to what is being done in carrying out the popular will. Suffice it to say that the city health commissioner, Dr. J. E. Crichton, was sent east to study institutions. Upon the ideas thus gained, plans and specifications were obtained and permanent buildings are now under construction. In the meantime the league had deeded over all its property to the city to be used for sanitarium purposes, and Mr. H. C. Henry is also erecting a $25,000 administration building as a memorial to his son who succumbed to this awful plague. Thus this noble work is fairly provided for, and the burden rests upon the public where it properly belongs.

AN ACCOUNT OF THE REFERENDUM ON THE PROPOSITION TO ESTABLISH A TUBERCULOSIS HOSPITAL IN AND FOR THE COUNTY OF ST. LAWRENCE, NEW YORK STATE.

GEORGE J. NELBACH,

Assistant Secretary, New York State Charities Aid Association.

Read before the Sociological Section, American Public Health Association, Colorado Springs, September, 1913.

In New York the county law authorizes the board of supervisors of each county to establish a tuberculosis hospital. There is no provision for a referendum in the law. In St. Lawrence County the board of supervisors, at its annual session in December, 1912, failed to vote affirmatively on the question, tabling, by a vote of twenty-two to eleven, a resolution committing the county to build a hospital, after two years' work.

Although it was pointed out that the law contained no provision for a referendum that would be binding upon the county, the board of supervisors passed a resolution to refer the hospital question to the people to be voted on at the spring town elections on February 11, 1913, and instructed its committee on public health to draft a uniform statement to be submitted to the electorate of each town. This committee, however, failed to report before the close of the session, and apparently it was not intended that the committee should report. Subsequently the supervisors of eight of the thirty-two towns in the county decided to obtain an informal expression of the opinion of their constituents at the spring elections.

St. Lawrence is the largest county territorially in New York, having an area of 2,880 square miles; the population is 89,005. It is also one of the most rural counties of the state, there being but one city, Ogdensburg (population, 15,933), and few large villages. Fully one fourth of the county lies within the Adirondack Mountain region. The county is located in the extreme northern part of the state and is bounded on the northwest by the St. Lawrence River and on the north by the Dominion of Canada. The winters are severe; railroads are all branch lines, and the train service, especially during the winter, is infrequent and unreliable. The people generally are conservative and slow to take up new ideas and enterprises. One frequently hears the county referred to as "rock-ribbed St. Lawrence," and as a "black Republican county."

A brief statement is given of the situation in each of the eight towns confronting those seeking to carry the referendum:

Town of Canton. Population, 6,151, including the incorporated village of Canton with a population of 2,701. Two weekly newspapers: one favorable to the hospital; the other strongly opposed on ground of expense; published misleading articles and claimed that the Friedmann treatment made the provision of a hospital unnecessary. Active local tuberculosis society. Supervisor favorable to the hospital.

Town of De Kalb. Traversed across one corner by a railroad. Population, 2,516, rural. No incorporated villages. No newspapers. No local tuberculosis committee. Supervisor opposed to the hospital.

Town of Fine. Located in Adirondack Mountains. Population, 2,234, rural. No incorporated villages. No newspapers. No local tuberculosis committee. Supervisor favorable to the hospital, wife having died of tuberculosis.

Town of Gouverneur. Population, 6,020, including incorporated village of Gouverneur with a population of 4,218. Two weekly newspapers, both favorable to hospital, one especially so. Active local tuberculosis society. Supervisor opposed to the hospital.

Town of Hammond. Population, 1,745, including the incorporated village of Hammond with population of 404. One newspaper, which favored the hospital. Active local tuberculosis society. Supervisor opposed to hospital.

Town of Oswegatchie. Population, 18,168, including city of Ogdensburg with population of 15,933. Three newspapers: one daily; two weeklies; all favored the hospital, especially the daily. Active local tuberculosis committee in Ogdensburg. Supervisor favorable to the hospital.

Town of Potsdam. Population, 8,725, including incorporated villages of Potsdam (population 4,036) and Norwood (population 1,993). Three weekly newspapers, all favorable to hospital. Active local tuberculosis societies in Potsdam and Norwood. Supervisor opposed to hospital.

Town of Russell. No railroad. Population 1,842, rural. No incorporated villages. No newspaper. No local tuberculosis society. Supervisor opposed to hospital.

About a month before the spring elections the State Charities Aid Association, the organization engaged in the campaign against tuberculosis in coöperation with the State Department of Health, was apprised of the intention of four supervisors to refer the hospital question to their constituents. Two weeks before the elections we learned that there would be referenda in three other towns, and on only four days before the elections we heard that the supervisor of the eighth town, and one of the most rural ones at that, intended to have his constituents pass upon the question.

A field agent was sent to the county a month before election to direct the campaign, and he was joined later by four assistants from the State Health Department and two others from our Association.

The field workers wrote news articles and editorials for the newspapers and had paid reading notices scattered through the pages of the last issue of each paper before election. No effort was made to hold mass meetings because these would be too expensive and the weather was too unreliable. Instead, each field worker secured the privilege of the floor at meetings of all kinds of organizations. Addresses were made before lodges, fraternal organizations, women's clubs and granges, and the passage secured of suitable resolutions on the part of these societies. The favorable action taken and the resolutions adopted by each society were printed in the

papers. On Sundays the hospital question was presented from the church pulpits, and in several towns union services of the churches were held. Personal interviews were had with doctors, clergymen and leading citizens generally, and they were urged to vote favorably and to ask their friends to do likewise. Effective assistance was rendered by members of local tuberculosis committees in the canvassing of the voters in the towns where such societies existed.

Cards, 11 x 17, were displayed in the shop windows, in the post offices, general stores, and on trees and telegraph poles, bearing the injunction, "Cast a Vote for the County Tuberculosis Hospital and Do Your Share toward Stamping Out the Disease." Small cards were inserted in the pay envelopes of those employed in the industrial establishments of the city of Ogdensburg and several of the larger villages.

A week before election the State Charities Aid Association sent from its headquarters in New York City to each enrolled voter in each of the towns a copy of the January issue of the *State Charities Aid Association News*, the society's publication, and in which appeared a four-page statement of the report of the county investigating nurse on 222 cases, throwing into startling prominence conditions surrounding uncared-for tuberculosis in the county. This was followed up two days before election with a mailing card to each voter, giving the estimated cost of construction and maintenance of a hospital for St. Lawrence County, a picture of a hospital in another county and a summary of the reasons for hospital provision. This was used not only as a follow-up method, but also to refute statements made by a newspaper and several public officials and others opposed to the hospital, greatly exaggerating the cost of hospital provision and claiming that patients would be forced to go to the hospital and detained there against their will.

On election day several paid assistants and a number of volunteer workers were stationed at the several polling places in each of the towns, and as the voter approached the polls he was asked to vote favorably and at the same time was handed a small slip of paper printed, "Vote 'Yes' on the County Tuberculosis Hospital Question."

These paid assistants and volunteers had been drilled by the field workers on the arguments for and against hospital provision and were able to answer inquiries and meet objections made by the passing voter.

The results of the referendum in each town were as follows:

Town.	*Yes.*	*No.*	*Majority.*
Canton,	887	465	422
DeKalb,	352	212	140
Fine,	(Carried, but record not kept.)		
Gouverneur,	1,001	115	886
Hammond,	257	84	173

Oswegatchie,	1,225	214	1,011
	(Including city of Ogdensburg.)		
Potsdam,	623	163	460
Russell,	191	154	37
Total,	4,536	1,407	3,129

The total majority was three to one, and in the several towns the majorities ranged from 1.24 to 1 to 8.70 to 1.

What effect this informal referendum taken in eight towns will have on the supervisors of the remaining twenty-four towns when the hospital question is considered at the annual session next December, is a matter of conjecture. Undoubtedly the effect in some cases will be salutary. At a special session of the board held last April and lasting only one day and at which only routine business was transacted, an effort was made to secure favorable action on the hospital question. But the objection that the newly elected members should not be required to vote on such an important question without full opportunity to familiarize themselves with it, prevailed, and consideration of the hospital resolution went over until the annual session. It was noted with satisfaction that the supervisor of each of the towns holding a referendum voted to take favorable action immediately, and that several of them who were opposed to hospital provision before the referendum argued vigorously for the hospital. Since the special session, two of the influential newspapers in the county have forecasted favorable action at the annual session.

The results of the referendum have been very encouraging to the public health workers in New York State. We now know that the people are with us. We now know that the people, when posted on this question, place the man above the dollar. Having carried the referendum in a county so distinctly rural as St. Lawrence, we feel confident that a referendum can be carried in any county in the state. We think we see in the referendum a short cut for securing affirmative action on hospital projects in counties where boards of supervisors fail to make the needed appropriations. It is not unlikely that we shall soon seek from the legislature an amendment to the law whereby, upon the petition of a percentage of the voters of the county, the question of establishing a tuberculosis hospital can be referred to the people.

EXAMINATION OF RIVER BOTTOMS AT PHILADELPHIA.

W. L. Stevenson,
Assistant Engineer, Sewage Disposal, Bureau of Surveys.

Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

The officials of the Bureau of Surveys for several years have been studying the problem of the collection and disposal of the sewage of the city of Philadelphia, in order to prepare a plan for submission to the State Department of Health, in accordance with the Act of April 22, 1905, which controls the discharge of sewage in the waters of the state of Pennsylvania.

Early in these studies it was evident that the Delaware River must be the ultimate point of disposal of the sewage of the city, no matter how it would be collected or treated.

The condition of this river was, therefore, especially important, 1st: As showing the effect upon it of the present method of discharge of crude sewage from the sewers, and, 2d: In order to determine the probable degree of treatment required in order to maintain the river in a clean condition when the population of the city increased and when the sewage would be collected and discharged at a few points.

Over a period of two years the condition of the river water at various points was observed, principally by means of the dissolved oxygen test, as this gives the results of the activity of the biological forces at work in their effort to purify the polluting materials discharged into the river.

It was also necessary to know whether the depletion of dissolved oxygen in the river water was due to the dissolved and suspended organic matters or to deposits of sludge of sewage origin upon the bottom of the river. To determine this latter fact the examinations of the river bottoms herein described were undertaken.

Conditions at Philadelphia.

The city of Philadelphia is situated on the west bank of the Delaware River, about 100 miles above its mouth; it is about 2,000 feet wide, has a channel approximately 30 feet deep, and a tidal range of $5\frac{1}{2}$ feet.

The flow of upland water above Philadelphia, in months free from freshets or drought, is estimated at 4,050 second-feet, and during the tidal flow 2,421,000,000 cubic feet of water flow past the city in 7 hours, 32 minutes.

The Schuylkill River flows through the city and discharges into the Delaware River near the southern end. The normal flow of the river amounts

to 1,270 second-feet. About midway in its distance through the city there is a dam, forming a pool, from which the city takes one-third of its water-supply, the remaining two-thirds being taken from the Delaware River near the northern boundary of the city. Both river waters are purified in slow sand filters before delivery to the consumers.

The built-up portion of the city of Philadelphia is very completely sewered upon the combined system, which discharges into the creeks and rivers. That part of the water-shed of the Schuylkill River within the city limits and above the aforesaid dam is sewered upon the separate system, the sanitary sewage being conveyed by an intercepting sewer to a point below the dam and discharged into tidal water, in order to protect the source of the water supply.

Frankford Creek.

Along this creek there are several pools in which the velocity of the water is inadequate to keep sewage solids in suspension, and the bottom of the creek is covered in such places with a heavy deposit of sewage sludge. In warm weather digestion occurs, thereby liquifying and gasifying a part of the organic matter of the deposits.

While this creek carries the sewage from a population of about 140,000 persons and much industrial waste, when it is discharged into the Delaware River it contains much less material capable of settling than would be produced if sewers from an equal population discharged directly, due to the natural sedimentation, digestion and liquifaction.

Lower Schuylkill River.

The portion of the Schuylkill River below the dam is tidal and has very low velocities of flow. During times of drought, due to the demands upon the river for water supply, almost no upland water flows over the dam and as the sewage from about 455,000 persons in Philadelphia is discharged into this portion of the river, the water is grossly polluted. With the exception of a few portions of this part of the river where the channel is narrow and higher velocities caused, the entire bed of the lower Schuylkill River is covered with deposits of sewage origin. Near the mouth, where the river is broader, they are several feet thick and cause, even in cold weather, constant ebullition of gas. The waters of the Schuylkill River when discharging into the Delaware are almost exhausted of dissolved oxygen. This is probably caused not only by the fresh sewage added each day but also by the putrefying deposits on the bed of the river.

As in the case of Frankford Creek, the deposition of the settleable matter from the sewage upon the bed of the Schuylkill River and its subsequent digestion and liquifaction very materially reduces the amount of sludge producing material reaching the Delaware River from the Schuylkill River.

Delaware River.

The sewers discharging into the Delaware River do not generally have their outlets in or near the channel where maximum river velocities exist. Along the developed river front they mostly discharge at the bulkhead into the docks where there is very little movement of the water due to obstructions of the piers. In these cases deposition of sewage matter occurs as in the case of Frankford Creek and the Schuylkill River.

There is, therefore, discharged into the main channel of the Delaware River from the docks, from Frankford Creek and from the Schuylkill River, sewage from the entire city of Philadelphia, with a population of 1,600,000, which has been subjected to a crude form of natural sedimentation.

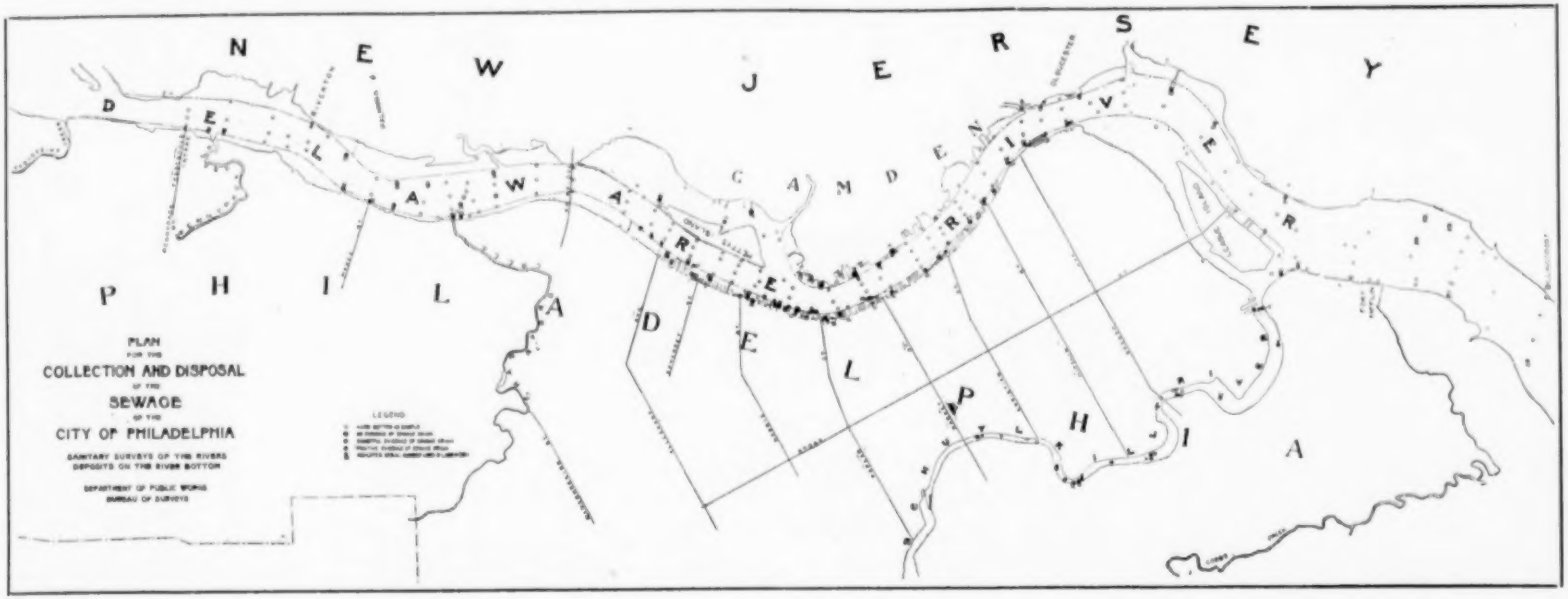
The velocity of the main channel of the river during the tidal flows is quite high and sufficient to maintain in suspension the finely divided sewage matters. The entire bed of the Delaware River in front of and below the city of Philadelphia, except in the docks near sewer outlets, is practically free from deposits of sewage origin. In fact, it was found impossible, with the apparatus used, to collect any samples of the bottom over a large part of the river.

On the accompanying diagram there is shown the points at which the river bottom was examined. The light open circles represent where the bottom was so hard that no sample could be collected. The heavy open circles represent points at which a sample was obtained but its examination showed no evidence of sewage origin. The half-filled circles represent samples in which it was doubtful if the material found was of sewage origin. The full circles represent samples of undoubted sewage origin, as determined by the presence of such objects as hair, paper, vegetable and meat fibres, etc.

Field Methods.

The samples of the river bottom were obtained from a boat whose location was determined at the time of sampling by sextant observations of known locations on shore.

Several types of apparatus were tried in order to obtain samples, even when the deposit was hard and of only a thin layer. The form finally adopted consisted of a heavy galvanized cylinder six inches in diameter and nine inches long. The top had a hinged cover capable of being raised only and with a rubber gasket seat, so that when the apparatus was hauled up the sample would not be washed out. To the lower part of the cylinder was soldered a galvanized iron cone in which lead was poured to weight the point. About where the cone joined the cylinder were four round holes one inch in diameter and provided on the inside with hinged valves only capable of opening inward.


NEW JERSEY
DELAWARE
CAMDEN
PHILADELPHIA
PLAN
FOR THE
COLLECTION AND DISPOSAL
OF THE
SEWAGE
OF THE
CITY OF PHILADELPHIA
SANITARY SURVEYS OF THE RIVERS
DEPOSITS ON THE RIVER BOTTOM
DEPARTMENT OF PUBLIC WORKS
BUREAU OF SURVEYS
LEGEND

When this apparatus was lowered to the bottom it sunk in the deposit which was admitted to the inside through the four small holes. It was then moved up and down a few times to cause it to fill more completely. The valves prevented the deposit from flowing out or water flowing in while it was hauled to the boat. The supernatant water was poured off and a pint jar filled with the deposit, its characteristic noted, such as "sandy," "foul odor," "thin mud," etc.

Laboratory Methods.

The samples were not examined in the laboratory until the following day. When the jars were opened the odor was noted. If gas had accumulated in the top of the jar it was tested with a flame to see if it would burn, and, if not, again tried while the contents of the jar were being stirred. 50 cc. of the deposit was placed in a pint jar, which was filled with aerated tap water. This was kept at room temperature for about five days, when the amount of dissolved oxygen consumed by the deposit was determined, to show the putrescibility or stability of the sample.

The sample in the original jar was emptied into a sand sieve having 20 meshes per inch, which was then alternately moved up and down in a flat cylindrical glass vessel containing clean water. This washed the finely divided mud through the sieve. The operation was completed by using fresh water until the débris in the sieve was freed from mud.

In undoubtedly polluted samples the microscopist had no trouble in at once fishing out characteristic débris of sewage origin. From samples not grossly polluted the débris was fished out of the screen and cleared up in 10 per cent. hydrochloric acid, then mounted in glycerine and examined under the microscope.

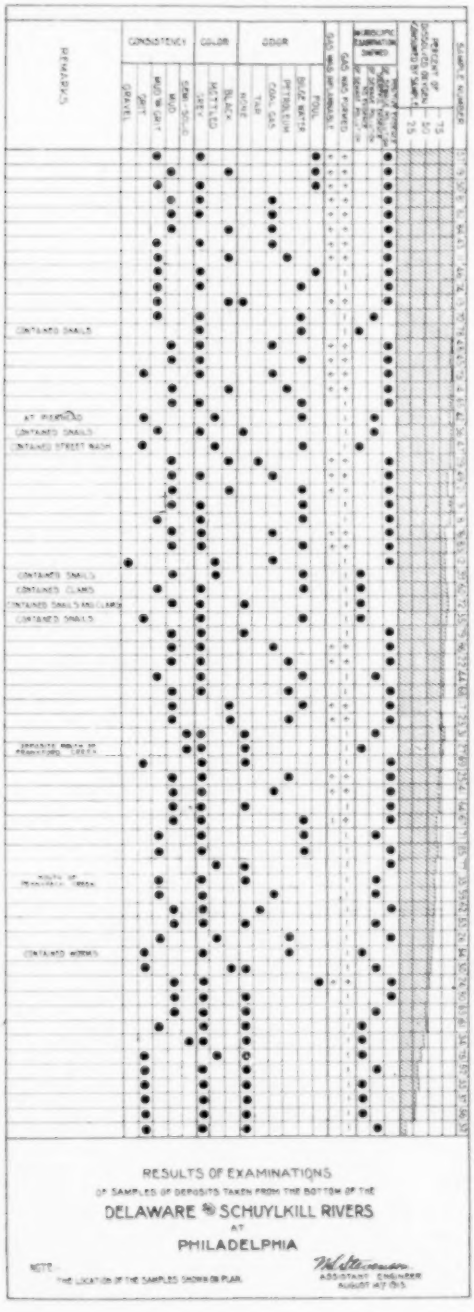
Permanent mounts were made of various materials, such as fibre from linen, silk, wood, vegetables and different kinds of meats. To these were added known objects recovered from the samples. These served as standards for the identification of unknown objects obtained from the river bottom.

Conclusions Drawn from the Observations.

It was reasonable to expect that samples which exhausted the dissolved oxygen in the laboratory, formed inflammable gas and emitted foul odors, were of sewage origin, and that samples which did not materially exhaust the dissolved oxygen, did not produce gas and were inodorous, would not contain evidence of sewage pollution.

These two statements were well borne out by the observations. The interesting features observed were the exceptions, among which the following may be noted:

A sample collected on the New Jersey side of the river at the end of the



RESULTS OF EXAMINATIONS
OF SAMPLES OF DEPOSITS TAKEN FROM THE BOTTOM OF THE
DELAWARE & SCHUYLKILL RIVERS
AT
PHILADELPHIA

NOTE — THE LOCATION OF THE SAMPLES SHOWN ON PLAN.

W. L. Stevenson
ASSISTANT ENGINEER
AUGUST 1ST 1915

water-works wharf showed no evidence of sewage pollution when examined microscopically, no gas was formed in the sample and it did not have an offensive odor. The sample, however, completely exhausted dissolved oxygen in the tap water added to it in at least four days. This inconsistency is explained by the presence of a large number of snails in the sample and serves to show that methods of examining river mud based entirely upon chemical observations may lead to fallacious conclusions.

On the other hand, samples which the microscopist reported as containing ample evidence of sewage pollution did not materially exhaust the dissolved oxygen, did not form gas and were practically inodorous.

The interpretation of this anomaly may be that while the deposit from which this sample was taken was originally of sewage origin, fermentation and decomposition had so destroyed the organic matter in the deposit that it was no longer in a putrescible condition and only the more resistant structures, such as hairs, linen fibres and cellulose still remained to indicate the original source of the deposit.

This would show that conclusions based solely upon microscopical observations are not complete, and it is the writer's opinion that fair conclusions can only be drawn from observations including microscopical examination, physical observations and a determination of the putrescibility of the sample as measured by its power of deoxygenating water.

In the accompanying table the characteristics of some of the samples are given, which support these ideas.

ACKNOWLEDGMENTS.

The writer wishes to give due acknowledgment to Mr. George S. Webster, Chief Engineer, Bureau of Surveys, for permission to use the data herein given and for helpful advice and suggestions during the work; to Mr. George E. Datesman, Principal Assistant Engineer, Bureau of Surveys, for his valued suggestions, based upon his intimate knowledge of the Delaware and Schuylkill Rivers; to Dr. George A. Soper, President of the Metropolitan Sewerage Commission, New York City, for advice and suggestions additional to the published method used by that Commission in New York Harbor; to Mr. Wm. B. Erichson, who had charge of the field work and chemical examinations in the laboratory; and to Dr. Carl Stienke and Dr. J. Douglas Blackwood, who made the microscopical examinations.

WATER SOFTENING AND DECOLORIZATION.

W. A. SPERRY,
Chief Chemist, Grand Rapids Filtration Plant, Grand Rapids, Mich.

Read before the Laboratory Section, American Public Health Association, Colorado Springs, September, 1913.

The first six months of experience at the Grand Rapids Filtration Plant has demonstrated that no plant can be successfully run by "rule of thumb." Every water supply, especially if it be a surface water supply, carries some features that make the treatment of that water distinctive and set apart.

The Grand Rapids plant started full normal operations about November 1, 1912, drawing water from the Grand River. It being originally proposed to soften this water down to about 125 p. p. m. total hardness or what is generally known as the Lake Michigan standard and to reduce its color to 10 parts p. p. m. or less on the Platinum Cobat scale.

The Grand River drains an area of some two thousand square miles of sandy soil full of marshes and small lakes with but little clay ground, being largely adapted to orchards and small fruits. Moreover, the water is quite hard due to lime stone outcroppings.

When one steeps tea-leaves in water there results a color, an odor, and a taste. The distinctive problem at the Grand Rapids plant has proved the removal of the effects of the steeping of the meadows in water that subsequently reached the Grand River. The problem was rendered more difficult in that in addition to its color the water was hard and hard waters seem more difficult to decolorize than soft waters, provided there is an absence of clay.

In this respect it is interesting to compare the water supply of Columbus, Ohio, with that of Grand Rapids. The Grand Rapids supply, as noted above, is drawn from a sandy soil underlain with lime rock containing but little clay and with much vegetation, and spotted all over with lakes and ponds.

The Columbus supply is taken from the Scioto River which flows through a limestone region wholly clay and devoted to general farming operations with little or no swampy ground and but little sand.

This results in a water at Columbus whose turbidity and total hardness rises and falls through great ranges in very short periods of time—it being not unusual for the turbidity, for instance, to increase from 25 parts per million to 2200 p. p. m. in a period of eight hours following heavy rains over the watershed with a corresponding decrease in the hardness of the water.

These phenomena are due to the clay nature of the soil which lacks the "soaking up" and conserving capacity of lakes and sand and makes the Columbus problem largely one of coping with rapid changes of turbidity and hardness but with the color problem removed in that the presence of much clay in this water tends to absorb and therefore eliminate its color.

At Grand Rapids, on the other hand, the highest turbidity observed in the past six months has only been 135 p. p. m. with and average turbidity of 20 p. p. m. Moreover, due to the watershed being twice the area of the Scioto watershed, and due to the much sand and many small lakes which tend to absorb and conserve storm water, the river does not rise and fall so rapidly nor does it get very turbid, and because of the absence of much suspended clay—turbidity—the color as well as a slight marshy taste and odor which accompanies the color is much more persistent and difficult of removal. A secondary effect in rendering the color, odor and taste more difficult of removal is found in the opportunity for leaching out of the vegetable matter over the watershed offered by the conditions of which tend to hold back the water.

An interesting result of this condition is found in the summer time, when, following a general rain, the color and taste become more pronounced, due to the washing into the stream of pools formed as a result of low water, where this leaching effect has become exaggerated.

Ordinarily sulphate of alumina or iron are used as decoloring agents their efficiency depending on the fact that the reaction between the natural alkalinity of the water and the alumina or iron tends to break the latter up with the formation of alumina or iron hydrates whose physical properties of weight, insolubility, and the possession of a bulky gelatinous mass, tends to make them absorb and reduce color and the accompaying odor and taste.

In the case of very soft and highly colored waters such as are found in the East, it is necessary to supply a sufficient alkalinity to decompose the sulphates of alumina or iron in the form of lime hydrate or slacked "quicklime" and iron has in almost every case been found to work more efficiently when accompanied with sufficient lime to produce a slight excess of hydrate alkalinity even though there be already present in the water sufficient bicarbonate alkalinity. Moreover, iron seems to exert more decolorizing and deodorizing power on some waters than alum as is claimed for its use at a plant recently completed at Fargo, North Dakota, though alum seems much more generally applicable. Where iron can be used it proves quite desirable due to the lesser expense of iron as compared to alum.

The total hardness of the water at Grand Rapids has averaged 217 p. p. m. with a maximum of 288 p. p. m. and a mimimun of 104 p. p. m. This has been accompanied by an average color of 32 p. p. m. and an average turbidity of 20 p. p. m.—the color ranging from 16 to 55 p. p. m. and the turbidity from 5 to 135 parts per million as minima and maxima. This

total hardness is made up of the bicarbonates of calcium and magnesia averaging 188 p. p. m. accompanied by about 30 p. p. m. of sulphates and and average of 17 p. p. m. of magnesium for the past six months.

The first few days of operation showed that the amount of alum necessary to produce a water whose color was 10 p. p. m. or less was excessive—a water carrying a color of thirty to forty parts per million requiring three to four and one-half grains per gallon of alum to produce a water of the above requirements. Such treatment was not only expensive but so increased the sulphate or permanent hardness as to produce a very disagreeably hard water.

Meantime laboratory experiments indicated that the use of lime would not only soften the water but decolorize it as well and at less expense.

It is oftentimes a puzzle as to why "lime" is used to remove "lime." It is a basic chemical principle that an acid will combine with an alkali to produce a neutral body which is neither acid or alkaline. Calcium and magnesium salts are largely present in a water by virtue of the solvent action of the carbonic acid gas dissolved in the water and are therefore present in an acid condition. By the addition of an equivalent amount of an alkaline form of lime—calcium hydrate—there is produced a neutral body which is insoluble and if there should be five parts of such acid calcium or magnesium present in a water the addition of five parts of calcium hydrate—an alkaline form of lime—would precipitate out of the water 10 parts of lime which would contain the lime added as well as the lime present in the water. Moreover, magnesium so precipitated has much the same form physically as do the hydrates of alumina and iron and is available for the same uses—as coagulants to remove turbidity or color.

It was proposed therefore to utilize the magnesium in the Grand River water supply through the softening process as a decolorizing agent.

Ordinarily the softening processes can be carried to any point desired up to the full neutralization of all acid lime present. At the Grand Rapids plant however, it was soon found that unless sufficient lime were added to completely neutralize all bicarbonate or acid alkalinity that the magnesium was not precipitated in a form to be sufficiently available for decolorizing purposes and therefore we were compelled either to soften the water to a point much lower than the 120 or 125 parts per million desired or else operate at greater unit cost in that a partial softening of the water made it necessary to use two to three grains of alum in addition to the lime to produce a satisfactory color.

On the other hand, by the addition of lime sufficient for the full neutralization of the bicarbonates present, it was found that we could produce a water whose color was 10 or less and whose total hardness ranged from 88 to 100 parts per million for the past six months. By so doing we were able to reduce the alum required to an amount as low as one-fourth grain per

gallon, its function being largely to help carry down the fine crystals of calcium carbonate formed in the softening process.

From the standpoint of the consumer, this was excellent, in that the water so produced was soft enough to lather freely in the cold and without the formation of the "scums" that are so disagreeably characteristic of hard water as well as a water whose color was no longer noticeable. In addition this later method of treatment enables us to operate at a much less cost per million gallons than by the use of alum.

The use of alum, then, offered as an advantage color removal alone and as disadvantages increased cost of operation and increased hardness of the water produced.

The use of lime offered as advantages the reduction of both hardness and color at greatly reduced cost as compared with alum, the disadvantages from the operators' standpoint being that once the people of any community become accustomed to a very soft water they also become sensitive to any upward changes of hardness and are therefore liable to notice and object to any increases in hardness later on.

So far as we have been able to study and observe our problem this method of treatment with lime has proved most efficient and economical for all classes of waters the seasons have brought to our plant. Whether the color drop to as low as 20 p. p. m. as in the hard waters of the summer time or rise to 60 or 70 p. p. m. following the spring floods it requires excessive amounts of alum for its removal, and lime, therefore, proves most efficient save for these short periods when the total hardness gets as low as 100 to 120 p. p. m. with the magnesium in the water falling off to 10 to 15 p. p. m., at which time alum must of necessity be used.

The average reduction of magnesium in the filtered water as compared to the river water following such treatment as the above has been 25 per cent.

THE EFFECT OF RENOVATION OF BUTTER UPON THE REICHERT MEISSL NUMBER AND SAPONIFICATION VALUE.

F. O. Tonney and F. W. Stockton.*

Read before the Laboratory Section, American Public Health Association, Colorado Springs, September, 1913.

In connection with the examination of a series of samples of ice cream by the Health Department Laboratory of Chicago, in the course of which the presence of foreign fats was demonstrated in a few instances, the contention was raised by scientific counsel representing one of the ice cream manufacturers that reprocessed butter often yields a low Reichert Meissl number and saponification value; that, judging from the data furnished by these tests, it is often impossible to distinguish renovated butter from mixtures of butter and foreign fat. As a basis for this contention it was stated that the alleged lowering of the findings of these two tests was due to a loss of volatile acids occurring during the process of renovation, as a result of the heating and washing. The assertion was confidently made that the aforementioned loss of volatile fatty acids may represent as much as one third of the volatile fatty acid content, as determined by the Reichert Meissl method.

It was the opinion of the city's experts that the loss of volatile acids occasioned by the process of renovation would be slight, and would not in any case be sufficient to invalidate the test as a means of distinguishing genuine butter from other fats.

The firm in question admitted that renovated butter had been purchased for the preparation of homogenized cream, used in the manufacture of ice cream, but disclaimed any knowledge of the use of oleomargarin or other foreign fats for this purpose. The purchase of supplies, however, had not been controlled by laboratory tests.

As very little definite data could be found upon the point in question, however, it was decided to undertake the series of tests here reported. The procedure adopted was as follows:

Samples of butter purchased in the open market were subjected to tests for the determination of the Reichert Meissl number and saponification value. They were then placed in an incubator, at 37°C., for from three to five weeks, until an extreme degree of rancidity developed. The samples were then reprocessed by blowing steam through them for two

* From the Laboratory of the Department of Health, Chicago.

hours, cooling and washing the product; after which the determination of the Reichert Meissl and saponification values was again carried out.

The Reichert Meissl method described by Leffman and Beam was used, and the method selected for determination of the saponification value was that of the Association of Official Agricultural Chemists, Bulletin 107 (Revised) United States Department of Agriculture.

Thirty-two samples in all were subjected to examination, results of which are given below:

No.	Reichert Meissl Number.				Saponification Number.		
	Before renovation.		After renovation.		Before renovation.	After renovation.	
	Butter.			Difference.			Difference.
1.	Fresh	28.0	27.3	− .7	227.4	227.5	+ .1
2.	"	30.5	29.2	−1.3	232.4	232.3	− .1
3.	"	29.0	28.6	− .4	230.3	229.9	− .4
4.	"	31.4	30.1	−1.3	232.1	232.3	+ .2
5.	"	30.0	29.4	−1.3	231.4	231.2	− .2
6.	"	29.1	28.5	− .6	231.4	231.2	− .2
7.	"	28.2	27.7	− .5	229.5	228.7	− .8
8.	"	29.1	29.4	+ .3	229.1	229.5	+ .4
9.	"	28.3	27.9	− .4	228.6	228.6	0
10.	"	26.5	27.0	+ .5	229.0	229.2	+ .2
11.	"	29.5	28.8	− .7	229.3	229.4	+ .1
12.	"	27.7	26.8	− .9	228.0	228.0	0
13.	"	30.2	29.8	− .4	229.9	230.8	+ .9
14.	"	29.6	28.2	−1.4	228.8	229.5	+ .7
15.	"	30.0	29.1	− .9	231.8	232.4	+ .6
16.	Renovated	28.1	28.0	− .1	229.2	230.2	+1.0
17.	"	27.9	28.4	+ .5	227.9	227.7	− .2
18.	"	26.9	27.6	+ .7	228.2	227.4	− .8
19.	"	26.8	26.0	− .8	227.9	228.0	+ .1
20.	"	25.3	26.1	+ .8	228.7	228.9	+ .2
21.	"	24.8	26.0	+1.2	226.8	226.9	+ .1
22.	"	24.5	25.3	+ .8	226.8	227.2	+ .4
23.	"	27.0	25.9	−1.1	226.9	227.5	+ .6
24.	Fresh	28.2	27.4	− .8			
25.	"	26.5	26.2	− .3			
26.	"	24.1	23.8	− .3			
27.	"	24.0	25.7	+1.7			
28.	"	27.3	26.3	−1.0			
29.	"	26.4	24.6	−1.8			
30.	Renovated	26.3	27.6	+1.3			
31.	"	29.3	26.4	−2.9			
32.	"	29.3	25.4	−3.9			
	Average decrease..... − .48				Average increase.....+0.1		

The experiments were conducted under very rigorous conditions, both as to the degree of rancidity and the thoroughness of renovation, and in some cases also the renovation represents the second time that the butter had been reprocessed. It will be seen by examination of the table that

the variation of results before and after renovation is relatively small, while the average of the differences is practically nil. These findings are in accord with the results of a similar series of experiments made by Crampton* on the same subject.

The conclusion, we believe, may safely be drawn that any reduction in the two values mentioned occurring in the process of renovation of butter is practically negligible, and does not in any way affect the validity of the tests as means of distinguishing genuine butter from other fat mixtures.

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* "The Composition of Process or Renovated Butter," C. A. Crampton, *Jour. Am. Chem. Soc.*, 25, 1903, p. 358.

THE DECOLORIZATION OF THE LITTLE RIVER WATER SUPPLY IN CONNECTION WITH FILTRATION AT SPRINGFIELD, MASS.

ELBERT E. LOCHRIDGE.

Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

Sulphate of alumina as a coagulant and decolorizer is in use on many waters in the United States, and is recognized as one of the most effectual means of reducing an objectionable color in the water prior to filtration. The river water as applied to the West Parish filters of the Springfield water supply is naturally a water of few objectionable features. No large population is resident upon the water-shed and the sanitary conditions are excellent so that there is not a large danger of serious contamination of the supply at any time.

By filtration a water free from practically all objections is produced, except that at times, the remaining color is noticeable, and the present system of coagulation is the result of a study of the means of correcting this one objection to the water.

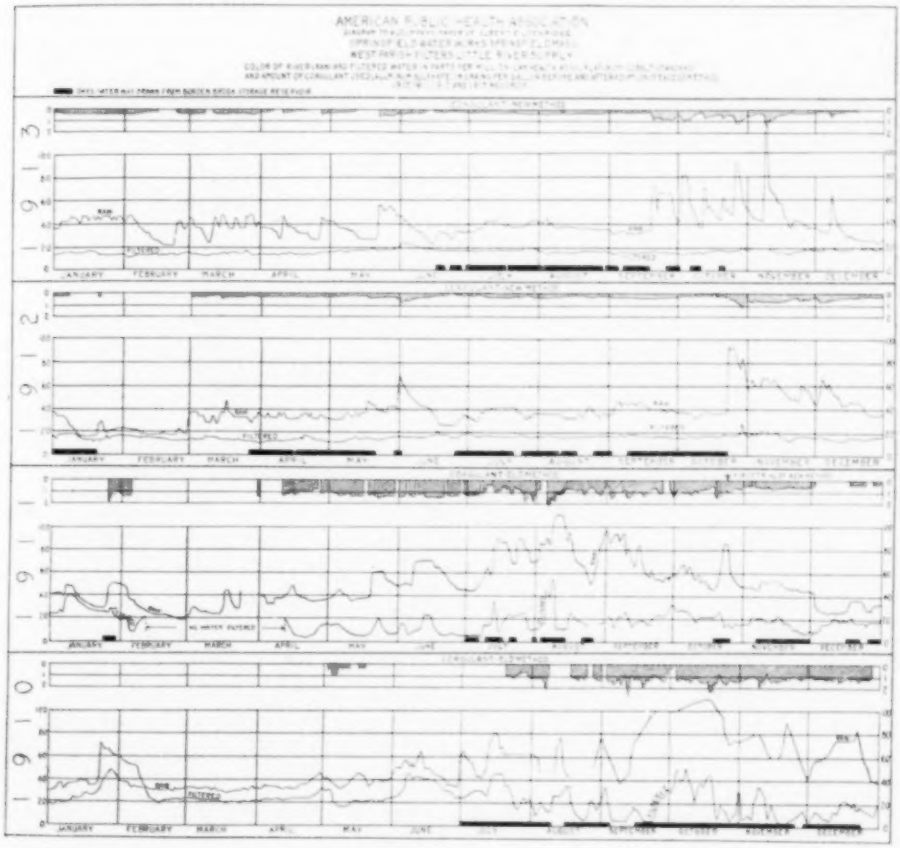
This water was first used as a supply in December, 1909, and sulphate of alumina was used for the reduction of color in the manner in which it is usually applied. The accompanying cut showing the use of coagulant during 1910 illustrates the amount of sulphate of alumina which was necessary for this reduction. Its application during this year was in accordance with the usual practice, that is, in amounts sufficient to secure a clear-cut reaction and the coagulant was applied continuously. The present method is illustrated by the chart showing the amounts and the color of the raw and filtered water during 1912 and 1913.

As at present practised, excellent color reduction is secured by the use of 0.2 grain of sulphate of alumina per gallon of water during a larger portion of the time.

METHOD OF APPLICATION AND DETERMINATION OF AMOUNT NECESSARY.

It has long been recognized that better results are secured from the sulphate of alumina in an acid water, and this fact may have some bearing on the results obtained. From ten to twenty samples of water are taken in two-gallon bottles and placed in a row on the laboratory table. To these are added varying amounts of sulphate of alumina from a standard solution, so that the effect of each amount is determined, both as to its final effect and as to the length of time necessary for reaction. For example, to the first bottle an amount which would be equal to one grain per gallon is added, to the second 1.1, to the third 1.2, etc., up to perhaps 2.0

or even 2.5 grains per gallon. In this manner for the water of that day the amount of coagulant is determined which will quickly throw down substantially all of the color with a good precipitate in a very short time. If, for example, this reaction is found to be 1.7 grains of sulphate of alumina per gallon, the feed apparatus for coagulant for the main supply is set for a feed of say 1.9 grains of sulphate of alumina per gallon. This amount



thus applied is always in excess of the amount necessary for the complete reaction and is also an amount which exceeds the available alkalinity of the water, so that in the prompt reaction obtained all of the alkalinity is used up and an excess of sulphate of alumina is applied to the water.

The application of this coagulant is made in a concrete conduit which delivers the water from the river into a settling basin having a capacity of about 40 million gallons, which is a little over three days' supply.

This rate of coagulation is continued for a period of from four to six hours

and then the coagulant is shut off entirely and the river water allowed to flow in its natural state into this same basin uninterruptedly.

The effect of this intermittent feed applied from 15 to 30 per cent. of the total time is twofold. In the first place the amount of water coagulated with a color substantially 0 is added to this large basin, and the effect of mixing of water of a color of 0 with water with a color of 40 represents one of the factors in the decolorization of the water. On account of the excess amount applied, a mass reaction has taken place and all of the alkalinity and coloring matter has been combined with the coagulant. A second reaction becomes effective at the outlet of the conduit where the water is thrown into contact with the remaining and uncoagulated water and this reaction has the further effect of neutralizing all of the sulphate of alumina not as yet precipitated. There is also another effect which has been recognized in some places in the application of a hydrate of alumina to water, in the effect which the flocs thus introduced but not precipitated at that point will have in the improvement of the water. These conditions produce when properly applied, a uniformly good water of satisfactory color, with a total expenditure for coagulant of not over 25 per cent. of the amount required if the coagulant is applied continuously.

Further information was obtained by applying the same amount of coagulant throughout the twenty-four hours or even twelve hours without any effect on the reduction of color whatever; so that it will be seen that it is necessary to get the clear-cut reaction which is noted above in the water actually treated.

The determinations outlined are made daily or at frequent intervals when little change is to be noted in the character of the raw water, but are absolutely necessary for the determination of the right amount to be applied if the stream is rising or falling, or changing in its nature as such streams do from day to day. It can also be seen that the alkalinity of the water plays but a minor part in this reaction, inasmuch as the hardness must be entirely utilized or combined only during the period of application; and it has been found by experiment that the changes in alkalinity have not been as important as have the source of supply. Different amounts were needed for the treatment of the water following rains where high level swamps have overflowed into the stream, from that necessary when water is drawn from the storage reservoir, and different amounts have been needed for water from the storage reservoir when drawn from different levels or at different seasons.

This method of treatment has an additional advantage in the removal of the necessity of adding soda ash or other chemicals for the hardening of the water, inasmuch as in the full reaction but a part of the alkalinity even of a very soft water is used.

Mr. Herbert F. Salmonde has been the chemist in charge of this work, and it is under his direction that the reactions have been determined on the Springfield water.

RATIONAL BASIS FOR THE SANITATION OF RIVERS AND HARBORS.

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Read before the Sanitary Engineering Section, American Public Health Association, Colorado Springs, September, 1913.

For the sanitation of rivers and harbors to have a rational basis, the work must be conducted upon principles concerning which right-thinking persons can agree. They cannot agree that in every case all sewage must be kept out of the water nor that unlimited quantities should be allowed to enter it. Many natural bodies of water can assimilate some sewage without appreciable harm to the public health and welfare and if the work of sanitation is to be conducted in an economical as well as efficient manner, it is essential that this asset should be intelligently utilized.

In determining what is rational, due consideration must be given to the question of expediency. It is necessary to consider what it is feasible, as well as what it is desirable, to accomplish. If the undertaking is not based upon an intelligent understanding of what is practicable, the result is certain to be disappointing.

There is often a disposition, especially on the part of health authorities, to impose unnecessarily severe requirements upon cities as the result of a too zealous effort for the public welfare. If the sanitation of rivers and harbors is to be conducted in a rational manner, due regard must be given not only to the health of the public, but to the practicability and cost of carrying out the desired improvements.

The work of sanitating rivers and harbors is essentially preventive work. The waters must not be allowed to become foul. It is extremely difficult to clean a dirty river and were it easy, it would not be wise to allow the water to become grossly polluted before the cleaning operations are begun. Paraphrasing Colonel Waring's remark in regard to street cleaning: "The effort should not be to clean dirty rivers, but to keep clean rivers clean."

Before undertaking to sanitate a river or harbor, an agreement should be reached as to the degree of cleanness which is necessary and sufficient under the circumstances. When this is done, the work will proceed with much more likelihood of success than where the effort is merely to accomplish the best results attainable with a given process. There is no transcendent virtue in any type of apparatus; experience shows that the efficiency of the best apparatus depends largely upon the care and intelligence with which it is operated.

The way in which a standard of cleanness should be expressed depends upon the manner and extent to which the polluting materials do harm. It is a mistake to suppose that a standard of purity can be formulated which will be suitable for all rivers and harbors. Conditions which constitute a nuisance in one situation may be quite permissible in another. A great deal depends upon the manner and extent to which persons and property may be affected. The way in which a river or harbor should be sanitated, therefore, depends upon the uses to which the water is put.

In preparing a standard of cleanness, it will be desirable to describe the conditions which are to be prevented rather than the quality of the water which should be maintained. Purity and cleanness are negative qualities, and it is the absence of the offensive and injurious which should be insisted upon. The degree of cleanness required may be termed the permissible limit of pollution or the standard of purity for the water. Whatever the term employed, the standard should be regarded as the limit beyond which the water is not to be allowed to become foul.

Some contamination is inevitable and should frankly be so considered, for excepting under unusual circumstances, it will be impracticable and unnecessary to keep all sewage out of the water. The water of which sewage is chiefly composed must go somewhere. If it is put upon the land, it will either pass over the surface or flow downward to the ground water and so be carried to the nearest open water course through the soil.

A standard of cleanness to be rational should be expressed in language which is simple and capable of ready interpretation. Formulas based upon chemical, bacteriological or other scientific data should be avoided as far as practicable as being unnecessarily involved and requiring interpretation before their meaning can be clearly understood. Sometimes chemical expressions cannot be omitted; in this event it is desirable that the most simple criteria be employed. When chemical standards are employed, it will usually be better to state the minimum percentage of dissolved oxygen which the water should possess than the maximum proportion of nitrogen compounds which are permissible.

In most instances, no criterion based solely upon the appearance of the water or its chemical or biological condition will be found satisfactory, and a standard of cleanness based partly upon the analytical composition and partly upon the pollution as it affects the senses will be found best.

The customary reasons for sanitating rivers and harbors are the prevention of sickness and the avoidance of nuisance, and the standard of cleanness should have reference to this fact. It is interesting to observe that although it is the prevention of sickness which is the more important consideration, it is the avoidance of nuisance which most often leads to improvements being made.

In regard to the danger of sickness, it is desirable to consider the imme-

diate channels by which the harmful substances in the water may cause disease. In practically every case where polluted water produces sickness, germs of disease are carried in some way from the water into the stomachs of the persons who are made ill. This transfer usually, but not always, occurs when the water is used for drinking purposes. In the case of tidal harbors, the eating and even the handling of shellfish from polluted bottoms may cause harmful germs to be taken into the system. Upon theoretical grounds, it would appear that there is danger in bathing in polluted water though there has been little evidence anywhere produced to prove that disease is frequently caused in this way.

Nuisances may arise from deposits of sewage solids either at the mouths of the sewers or at a considerable distance therefrom. In such cases the distance is usually short. In the worst instances, the waters become very polluted throughout, turn black and give off offensive gases. It is worth remembering that it is usually the deposits and not the water which produce these gases.

When the practicability of maintaining high standards of cleanness is considered, the problem of sanitating rivers and harbors is seen to be fraught with much difficulty. It must be admitted at the outset that no treatment can be given to sewage which will remove all the impurities except at high cost. The possibility of creating offensive conditions at the point where the works are situated must also be considered. Unless sewage works are situated in remote localities, they are liable to cause offense, especially such works as remove a large percentage of the impurities.

Nor can sewage, in the average case, be taken to some far-distant point for disposal without excessive cost. Cost is the great obstacle to the successful sanitation of rivers and harbors and must be continually balanced against the beneficial results to be attained. It appears to be hopeless to attempt to materially reduce the cost of sewage disposal by utilizing the manurial ingredients in the sewage except where the water itself is needed for irrigation.

Some ingredients of sewage can be extracted more readily than others and, fortunately, some of the most objectionable can be removed easily. It is comparatively easy to remove by screens those large solid particles which look offensive in the water and go far to produce deposits; but it is next to impossible to so treat the sewage as to remove the finer particles which cause the water to look turbid after the discharge. It is worth noting that those forms of treatment which are usually termed clarification seldom really clear sewage; they may remove a large amount of the suspended matter, but usually enough solids and semi-solids remain to cause the sewage to look turbid and to make the water into which it is discharged appear turbid also.

Instead of treating the sewage to make it perfectly clear, it is often better

to arrange the outlets so as to cause a prompt and complete dispersion of the sewage in the river or harbor. Sewage dispersion is by no means a simple matter. Especially when discharged beneath the surface of salt water, the sewage is likely to rise to the top by reason of its relative lightness, higher temperature and presence of air and grease and there remain.

For the sanitation of rivers and harbors to have proper basis, there should be provided a comprehensive plan for the reasonable disposal of the sewage, and this should be made out long in advance of the actual requirements. The plan should be in the nature of a program which can be followed out as time and the circumstances of the situation make necessary. The plan should be of such character as to provide all the protection needed for the river or harbor at an early date and be capable of extension so as to make the protection more complete as the quantity of sewage increases and the demand for clean water becomes more exacting.

THE EFFECT OF WATERS OF DIFFERENT QUALITY ON THE LONGEVITY OF SOME PATHOGENIC BACTERIA.

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Read before the Laboratory Section, American Public Health Association, Colorado Springs, September, 1913.

During experiments on the viability of different strains of a pathogenic organism in various concentrations of some inorganic salts, it was noticed that some variations occurred, and it was thought desirable to carry out a series of experiments for the purpose of determining the effect of waters of different quality on the longevity of some pathogenic organisms.

In the series of experiments conducted, the method of exposing the bacteria to the various waters was by means of permeable collodion sacs immersed in litre samples of the water contained in Erlenmeyer flasks and supported by cotton plugs. For the purpose of approximating, as nearly as was deemed practicable, the conditions which exist in nature relative to variations in the composition of flowing waters, the flasks were emptied and the contents replaced by fresh supplies of the respective waters six times a day. In this way any detrimental effect on the organism due to staleness of the waters, resulting from keeping in glass containers for long periods, was eliminated; and any variation in the vitality of the organisms effected by changes in the composition of the waters could be determined in this manner.

The sacs were made by using a ten per cent. solution of collodion in equal parts of absolute alcohol and ether. After air-drying for two hours and shrinking under water for two hours, the sacs were removed from the tubes with but little difficulty. All sacs were tested for permeability and integrity, and only those sacs which remained intact after exposure for one week were selected for the experiments.

The waters to which the bacteria were exposed were distilled (in glass) water, entirely free from salts and organic matter; Madison city water, a hard artesian supply containing a very small amount of organic matter; Lake Mendota water, which is quite hard and contains a relatively large quantity of organic material; and sewage, which may be regarded as a concentrated solution of organic matter. With such a series of waters it was believed that any variations occurring in the viability of the organisms due to the influence of salts or organic matter, or both, might be ascertained and studied.

The organisms used were B. coli, two strains of B. typhi, B. dysenteriæ, B. cholera suis, staphylococcus pyogenes aureus, a (pathogenic) streptococcus and B. diphtheria; and rejuvenated pure cultures of each organism, with the exception of B. diphtheria, were obtained on lactose agar. When making the suspensions, in order to eliminate the organic material of the agar, only a portion of the upper surface of the growths were transferred to sterile distilled (in glass) water; and each cubic centimeter of these various suspensions contained between one and two million organisms.

In the first series of experiments the collodion sacs were divided into four sets, and the sacs of the first set filled with about ten cubic centimeters of sewage; the sacs of the other three sets were filled respectively with the same amount of lake water, city water and distilled water, plugged with cotton and sterilized (sacs suspended in flasks nearly filled with water and sterilized in auto clave). Each sac in the first series was then inoculated with one cubic centimeter of a suspension of one of the organisms, and a similiar procedure repeated with the other three series of sacs. The sacs, partially filled with the waters and containing pure cultures of the respective bacteria, were then suspended by means of large cotton plugs in flasks containing litre samples of the same type of water contained within the sacs; and the flasks kept at room temperature. The waters in the flasks were replaced by fresh samples about six times a day. In this manner the effect of the diffusible substances in the waters on each type of organism could be studied free from the antagonism of the sewage and water bacteria.

Since the bacteria under observation were in pure cultures, it was unnecessary to employ special methods for their recovery, so the lactose agar plate method was used for the cultivation of all the bacteria with the exception of B. diphtheria, which was cultivated on blood serum: about five tenths of a cubic centimeter of the cultures were withdrawn each time from the sacs and placed in tubes containing slanted blood serum. Contaminations of the pure cultures due to breaks in the sacs were readily discernible by the appearance of different types of organisms on the lactose agar plates, and such contaminated tubes were eliminated from the experimental work.

Transfers from the sacs were made every other day, except in the case of B. diphtheria, which was transferred each day; and each type isolated was confirmed by cultural methods and microscopic examinations. The results obtained in this piece of work indicate quite conclusively the differences in the viability of the organisms under the same and different influences.

In this series of experiments, undertaken for the purpose of determining the effect of the diffusible substances and the by-products of the bacteria on the pathogenic organisms in general, and the influence of different

TABLE I.

LONGEVITY OF PATHOGENIC ORGANISMS IN PURE CULTURES EXPOSED IN PERMEABLE COLODION SACS TO THE DIFFUSIBLE SUBSTANCES OF SEWAGE, LAKE MENDOTA WATER AND MADISON CITY WATER.

Solutions contained in flasks.	Organisms exposed in pure cultures in sacs filled with the type of water in which sacs were suspended.							
	B. coli.	B. typhi. "A"	B. typhi. "B"	B. dysenteriæ.	B. cholera suis.	Staphylococcus aureus.	Streptococcus.	B. diphtheriæ.
Sewage.....	1d+ 30d+	1d+ 14d+ 16d−	1d+ 18d+ 20d−	1d+ 22d+ 24d−	1d+ 18d+ 20d−	1d+ 30d+	1d+ 16d+ 18d− 20d−	1d− 2d−
Lake Mendota water.....	1d+ 30d+	1d+ 16d+ 18d+	1d+ 22d+ 24d−	1d+ 26d+ 28d−	1d+ 16d+ 18d−	1d+ 30d+	1d+ 30d+	1d+ 2d+ 3d−
City water (artesian)	1d+ 30d+	1d+ 26d+ 28d−	1d+ 30d+	1d+ 30d+	1d+ 26d+ 28d−	1d+ 30d+	1d+ 30d+	1d+ 9d+ 10d−

amounts of nitrogenous material and inorganic salts in particular, the results obtained are quite interesting, and manifest quite conclusively the influence of waters of varied composition on the viability of the bacteria used. It was noticed as the work progressed that the bacteria per cc. fell from the high initial numbers to decidely lower limits within a few days. In all cases the decline in numbers was rapid and continuous during the first four or five days, and the great majority of the organisms disappeared during the first week; the bacteria remaining after that time were apparently the hardier ones capable of withstanding the detrimental influences of an unfavorable environment relatively much longer than the others.

It was also noticed that the pigmented organism, Staphylococcus aureus, after exposure to the waters for a week, became attenuated insofar as the loss of the power of secreting pigment was concerned; and several transplantations were necessary before this power was rejuvinated to its original strength.

One of the most interesting features of this series was the longevity of B. diphtheria in the city water. This organism was practically unable to resist the toxic influence of the liquids rich in nitrogenous organic material and the products of germ life, such as sewage and lake water; but in the case of the hard artesian city water, containing a very small amount of nitrogenous material, the organism survived for nine days. Such a combination of inorganic salts and nitrogenous matter, under these conditions, apparently fostered to a certain extent the development of this organism. After several days exposure it was noticed that there was a considerable change in the morphological characteristics of the bacillus as exhibited in

stained smears; the long granular, barred and clubbed-shaped types were transformed into short barred organisms, indicating that, while the bacteria were able to exist in this water, a progressive attenuation was taking place, which finally resulted in the destruction of the culture after nine days' exposure. The original morphological characteristics of the organism were, however, completely restored after several transplantations on blood serum of cultures transferred from the sacs before the ninth day. The results of these experiments were particularly striking and the work was repeated later with practically the same results.

The relatively short survival of the pathogenic organisms in distilled water—a few days only in most cases—was very probably due to the lack of food material; B. coli and the staphylococcus proving to be the most resistant of the group.

Comparing the effects of the diffusible constituents and by-products of the bacteria in the sewage, lake water and artesian well water on pure cultures of the pathogenic organisms, it appears that a solution such as the city water, containing a small amount of nitrogenous organic matter, exerted a less detrimental influence on the longevity of the bacteria than solutions rich in such matter.

The next series of experiments were undertaken for the purpose of ascertaining the effect of exposure of some of the pathogenic bacteria to the direct action of the organisms and their by-products, as well as the diffusible constituents, in sewage, lake water and city waters. The same method of arrangements and procedures mentioned in the first series were followed in these experiments, except that the solutions within the sacs were not sterilized before suspending them in the flasks. The permeable sacs were filled with the type of solution in which the sacs were suspended; the flasks were emptied and refilled with fresh liquid six times each day, and a study of each sac was made every day. In this manner the conditions which exist in nature relative to the exposure of pathogenic organisms in sewage and waters were approximated as closely as practicable.

In this series two strains of B. typhi, and one of B. dysenteriæ were exposed to the sewage and lake water; and in the case of the city water, which had a low bacterial content, varying from 10 to 40 on gelatin, and one or two non-acid-forming organisms on agar, B. diphtheria and streptococcus were also exposed. The number of the organisms added to the solutions in the sacs varied with the richness of the original bacterial content. To the sacs containing sewage about ten million organisms of each type were added; the sacs containing the other solutions were respectively innoculated with approximately one hundred thousand bacteria of each type.

As the organisms in this series of experiments were in direct contact with the bacteria of the sewage and the waters, it was necessary to employ

differential methods of cultivating B. typhi and B. dysenteriæ. For this purpose, lactose bile and Conradi-Drigalski agar was used for the presumptive detection of these two organisms.

The method of isolating B. typhi consisted in inoculating lactose bile with 0.1 of a cc. of the solutions transferred from the sacs, and after twenty-four hours' cultivation of the bile tubes at 37.5 degrees centigrade, cultures were made on D.-C. medium. In the case of B. typhi, several colonies exhibiting the microscopic characteristics of this organism on the D.-C. agar were fished, rejuvinated in dextrose broth, and confirmed by sub-culturing in milk, litmus lactose agar and peptone broth, and also by subjecting the culture to the agglutination test.

The same general methods of isolation were followed with B. dysenteriæ. The colonies fished from D.-C. agar plates were rejuvinated in dextrose broth, and sub-cultured in milk, lactose broth and mannite broth for confirmation.

The streptococci were isolated from the city water by means of litmus lactose agar; the diphtheria organisms were cultivated on blood serum. About 0.5 of a cc. of the solutions was removed from the sacs and placed in tubes containing slanted blood serum, which were incubated at 37.5 degrees centigrade for twenty-four hours. A portion of the resulting growth was removed, smeared on a glass slide, stained with methylene blue, and examined microscopically. The character of the growth on blood serum and the microscopic examination were used as confirmatory tests for this organism.

The result of this series of experiments are tabulated below, and show quite plainly the differences in the vitality of the same and different organisms in the solutions of varied composition.

It appears from a comparison of the results summarized in Table 2, that the longevity of the pathogenic organisms varied considerably according to the bacteriological content and the chemical composition of the liquid environments to which they were exposed; the hard city water, with its low nitrogenous organic content, appeared quite conclusively to be less detrimental to the growth of the typhoid and dysentery organisms than either the sewage or lake water.

The results indicate that sewage is relatively quite destructive to the infectious bacteria; it evidently was the most unfavorable of the three liquid environments, as a rapid destruction of the introduced germs occurred in the course of a few days. Strain "B" of the typhoid organisms appeared to be somewhat less susceptible to the inhibiting influence of sewage than strain "A," and to possess about the same power of resistance as B. dysenteriæ. The typhoid organisms died in from three to five days. No recoveries were made after the fifth day; and B. dysenteriæ disappeared before the seventh day. It appears from a comparison

TABLE 2.

LONGEVITY OF THE ORGANISMS EXPOSED TO THE DIRECT ACTION OF THE BACTERIA IN SEWAGE, LAKE WATER AND CITY WATER, AS WELL AS THE DIFFUSIBLE CONSTITUENTS OF THE LIQUIDS.

Solutions contained in flasks.	Days exposed.	Bacteria exposed.					
		B. typhi "A."	B. typhi "B."	B. dysenteriæ.	Streptococcus.	B. diphtheriæ.	Controls.
Sewage	1	+	+	+			−
	2	+	+	+			−
	3	+	+	+			
	4	−	+	+			
	5	−	+	+			
	6	−	+	+			
	7		−	−			
	8		−	−			
	9		−	−			
Lake water	1	+	+	+			−
	3	+	+	+			−
	10	+	+	+			
	11	+	+	+			
	12	−	+	+			
	13	−	+	+			
	14	−	−	+			
	15		−	+			
	16		−	+			
	17			−			
City water	1	+	+	+	+	+	−
	2	+	+	+	+	+	−
	3	+	+	+	+	+	
	4	+	+	+	+	−	
	5	+	+	+	+	−	
	17	+	+	+	+		
	18	+	+	+	+		
	19	−	+	+	+		
	20	−	+	+	+		
	21	−	+	+	+		
	22		+	+	+		
	23		−	+	+		
	25		−	−	+		
	26		−	−	+		
	30			−	+		

of these results with corresponding data in Table 1, that the diffusible substances of the sewage exerted a somewhat harmful action on the bacteria; but it is quite evident that the active destructive agents were the antagonistic sewage bacteria.

The longevity of the organisms exposed to lake water was materially increased, however, in comparison to their viability in sewage. The typhoid organisms were able to survive in lake water for twelve days, while B. dysenteriæ was isolated as late as the sixteenth day after inoculation. The viability of the two strains of B. typhi appeared to be approximately

the same, strain "A" disappeared from the water in about eleven days and strain "B" was not recovered after the thirteenth day. It appears from an inspection of the data that the lake water, with its moderately high nitrogenous organic and bacterial content, is less destructive to the pathogenic organisms than the highly polluted sewage.

Of the three liquids to which the bacteria were exposed, the city water retained viable organisms the longest; a comparison of the results shows that the germs persisted for an appreciably longer time in this water than in either the sewage or lake water.

There appears to be some variation in the longevity of the typhoid organisms in this set of experiments. The difference, however, in the length of time, four days, that the strains "A" and "B" were able to resist the destructive influences of similar environments is within comparatively narrow limits, and, as the variations in viability noted in the other two sets of this series are relatively small, no definite conclusion in regard to this point can be drawn, although in all this work strain "A" appeared to be slightly more susceptible to the unfavorable influences of the liquids than strain "B."

The dysentery organisms were recovered from the city water as late as the twenty-third day; a period of activity, relatively, considerably longer than in either lake water or sewage. The streptococci remained viable throughout the period; apparently the conditions in the water were more favorable to the growth of the streptococci than to any of the other germs, at least, this organism possessed the power of resisting the inhibiting influence to a much greater extent than the other forms.

In general, it appears from an analysis of the results of this series that polluted waters are much more destructive to the pathogenic organisms than relatively pure ones. It is quite evident from an inspection of the above table that the bacteria were able to survive for a much longer time in the city water, with its low bacterial and organic content, than in either of the other liquids.

Conclusions.

The pathogenic organisms exposed to sewage, lake water and artesian water showed a difference in viability in the same and in the different solutions. There does not appear, however, to be a very appreciable difference in the powers of resistance of the two strains of B. typhi under the conditions of the experiments.

The diffusible substances and by-products of the bacteria in the sewage and waters to which the pathogenic bacteria were subjected exerted an inhibiting influence on their growth, slight in the case of the artesian city water, with its low organic and bacterial content, but more marked in the polluted lake water and sewage.

Where the pathogenic organisms were exposed directly to the action of the bacteria of the sewage and waters, their longevity was considerably decreased, indicating that the antagonistic action of the bacteria of the sewage was more detrimental to the viability of the pathogenic organisms than the inhibiting influence of the diffusible substances.

In general, the data supports the conclusion that the longevity of the typhoid and related organisms is much shorter in waters highly polluted with nitrogenous organic matter and saprophytic bacteria than in waters of good quality containing small quantities of nitrogenous organic matter and low bacterial contents.

SECOND REPORT OF THE COMMITTEE ON COLD STORAGE.

Presented to the American Public Health Association, Colorado Springs, September, 1913.

In the first report of the Committee on Cold Storage there were twelve suggestions offered which, it was recommended, "in considering the question of regulation or legislation on this subject the committee believes . . . should be carefully borne in mind." Many of these suggestions we still believe should be so considered. Other of these suggestions are intended more for the guidance of the warehouse operator than for the legislator or administrative officer. We would therefore like to amend our first report so that we may not be understood as recommending legislation or official regulation along all the twelve lines suggested, but as offering some of the suggestions for the guidance of the cold storage warehouseman.

Some slight modifications are proposed to some of the twelve suggestions referred to as offered in our first report. Item 4, as submitted in report No. 1, suggested: "No article of food should be placed in cold storage which is not mature, fresh, free from disease or deterioration of any kind." It is obvious that the intent of this suggestion was to provide that food placed in cold storage should be in prime or the best possible condition for such food. It has been pointed out to the committee that some foods are best stored in an immature condition and that such articles as cheese, for instance, mature best while in cold storage. Suggestion 4 is therefore amended to read: "No article of food should be placed in cold storage which is not mature, fresh, free from disease or deterioration of any kind, or in a condition such that, if kept under proper cold storage conditions, it will be, when removed, wholesome and suitable for use as a food."

Some criticism has been received of suggestion No. 10, which reads as follows: "It is desirable that frozen cold storage food products be raised gradually to higher temperatures, varying according to the size and nature of the article of food, in order to preserve the tissues in their natural condition." It is pointed out that this suggestion does not meet with the present practice of handling frozen goods in many cases. The criticism presupposes that the frozen articles of food are to be raised gradually in temperature in each instance by the warehouseman. The committee desires to explain that it did not have in mind the method or the medium by which the end suggested should be brought about. In many cases, perhaps a large majority of cases, the warehouseman will, because of his facilities, be called upon to gradually raise the temperature of frozen foods before prospective consumption, while in other cases the retailer or even the consumer will be in a position to do this. The point which the com-

mittee wished to emphasize by this suggestion No. 10 is that such a procedure will, in the case of frozen foods, preserve the tissues in their natural condition, which is certainly desirable.

Suggestion No. 11 in our first report perhaps needs some little explanation. This suggestion reads as follows: "Articles of food should not be returned to cold storage which have once been released and raised to materially higher temperatures. When it becomes necessary to transfer food products from one cold storage warehouse to another the temperature should not be allowed to rise to a point favoring deterioration." In the distribution of foodstuffs, it will often happen that goods taken from cold storage may not be sold or consumed on the day they were removed. A strict interpretation of the above suggestion would prevent the return of such unused portions to the cold storage warehouse. The committee believes it to be inadvisable to return such unsold or unconsumed foodstuffs to cold storage for any extended term. If the material is still in good condition there can be no objection to returning it to the cold storage warehouse for temporary storage so that it can be disposed of on the next business day. Such foods should be carefully watched to see that they have not become unwholesome as a result of their exposure to higher temperatures.

In other respects, the committee sees no reason to modify or explain the suggestions contained in its report No. 1. (See appendix.)

During the year there has been a great deal of proposed legislation in a large number of states. Wherever possible we have gotten in touch with the introducers of the bills, sending a copy of our first report and offering assistance. In a few instances our offers were acknowledged and our suggestions requested. In the bills actually enacted we see little evidence of the legislators using any of the suggestions offered. Pennsylvania, North Dakota and Iowa have passed cold storage bills. Ten other states have bills pending, some of which may have since been passed, information to that effect not having reached us.

The committee believes that in all this legislation too much attention is being paid to the question of the length of time which various food products may remain in cold storage. The important point from a public health standpoint, as well as an economic one, is—are the foods wholesome when placed in cold storage and are they in like condition when removed. Such scientific investigation as has thus far been made is not sufficient to say that any given food will remain good in cold storage for a given number of months and beyond that will be unfit for food. Nor do these investigations support such time limitation legislation. The two important points which this committee would urge with all emphasis are: first, that foodstuffs be in proper condition when placed in cold storage; and, second, that foodstuffs not intended for immediate consumption be placed in cold storage at the earliest possible moment.

It seems axiomatic to say that a food unfit for consumption because of decay or disease will not be improved by a few weeks' or a few months' sojourn in cold storage. On the other hand, it can be asserted with little fear of contradiction that under optimum cold storage conditions, foodstuffs in good condition when placed in cold storage will remain so for long periods of time. The enormous waste of food products every year is due to the lack of a sufficient number of warehouses at points of production and to carelessness or inattention on the part of producers to the necessity for prompt cooling, and not to anything inherent in the cold storage process itself.

Your committee has given much thought and study to this latter phase of the subject. What is to be the future development of the cold storage business? We have considered this question along three lines, as follows:

1st. Scientific and Mechanical.

2d. Economic and Financial.

3d. Educational and Illustrative.

Scientific and Mechanical.

There can be no doubt that any large development of refrigeration must depend upon the use of machinery wherein every law of mechanics and physics is to be utilized as far as possible to the making of methods effective and cheap. The development of the whole subject for forty years has primarily depended upon improved application of these laws to refrigeration from a business standpoint.

Economic and Financial.

What has and will yet more develop these methods is the general distribution of hydro-electric energy to towns and rural districts, and the use of exhaust steam for refrigeration purposes. When small, mechanically cooled storage plants of from two to three horse-power can be installed for $500 to $700, run by electricity, it is plain that the economic use of refrigerating machinery has come within the limit of use of every shop-keeper who ought to be entrusted with taking care of and selling food products. Of course the large warehouses today illustrate the enormous possibilities of cold storage, of which the International Congress of Refrigeration, meeting in Chicago next week, is the concrete expression.

Your committee cannot fail to realize, however, that the application of refrigeration methods now generally made use of in the breweries, on the very premises where the product is made, and in the abattoirs, where the animals are killed, illustrates the scientific principles underlying cold storage which must under governmental license and supervision become universal in their application.

The very delicacy in composition and flavor of milk, eggs, and butter

and many fruits demands that the methods of a pre-scientific age be no longer tolerated, but that intelligent regulations, with inspection and encouragement through education, be gradually brought to bear upon every handler of food from the farmer to the small store-keeper.

Educational and Illustrative.

From the making of yeast to the last moment any food supply was consumed, the housewife of the olden time had to depend, at every stage, upon the care of those very changeable organic products if their conservation was to be possible. The egg peddler, the local butchers, bakers, and cheesemakers have broken down that fine old farm dairy system, while the local butchers, bakers and grocers have become simply transfer men largely from the city butcher shop, bakery and grocery to the consumer.

If the problem of cold storage is to approach solution, the producer, that is the farmer, must relearn how to conserve his food products. He must be taught, and the housewife must be taught, by demonstrations and lectures, that, in place of the old cool milk cellar with running water, how easily and cheaply their food products may be conserved with the ice house, refrigerator or even the small mechanical refrigerator.

When 20 per cent. of eggs reaching city warehouses is the usual average of candled eggs found unfit for cold storage, it is apparent that present methods are in no small degree factors, not alone in deteriorated food products, but in the excessive prices due to scarcity of supplies. Nowhere in the world is this scarcity today being so acutely felt as on the North American Continent, and nowhere may the general use of machinery and electricity or correct methods be more readily taught or more easily be brought into general practice.

With such methods instituted at the farm, the local cold storage at railway points, where produce is collected for shipment, is the natural complement.

The preservation of the food supply of the country being thus provided for systematically as a part of the routine of production, the ability to hold supplies in perfect condition at local points in quantities, making large shipments possible, would prove to be of all means the best regulator of the distribution and price of products. The farmers and local dealers' helplessness in the matter of holding supplies is counted on too often by buyers to depress or regulate local prices, often to a point where the producer, not being paid for his labor, either becomes indifferent to quality or ceases producing altogether.

It is illustrative of what many will have observed in connection with all proposed acts to regulate cold storage that the whole idea underlying the legislation is that there can be cold storage facilities only in the large centers, where great quantities of food are accumulated in warehouses, as

during the seven fat years of Joseph's premiership in Egypt preparatory, as it were, either to seven famine years or to war.

The suggestions contained in the report of your committee indicate quite different views of the needs of the situation, and we trust that their presentation herein may serve to impress not only on the members of this Association the dominating importance of refrigeration as a public health problem, but also to indicate to the producers, whether fruit growers, meat raisers, fishermen or what not, that the solution of the problem lies antecedent to those great centralizations of food which legislators are in some degree trying to regulate.

The committee gratefully acknowledges the suggestions and assistance extended by the Association of Refrigerating Engineers, the Cold Storage Warehousemen's Association, and the editors of *Ice and Refrigeration*.

Your committee respectfully recommends that the investigations which have been undertaken be continued through this or a similar committee.

Respectfully submitted,

DR. WARD L. BEEBE.
DR. PETER H. BRYCE.
DR. HIRAM BYRD.
DR. W. F. SNOW.
F. D. BELL, *Chairman*.

APPENDIX.

Below will be found the twelve suggestions recommended in our first report, revised and amended as proposed in our report No. 2.

In the operation of cold storage warehouses and in any discussion of the question of regulation of, or legislation on, cold storage, the committee believes the following suggestions should receive very careful consideration:

1st. "Cold Storage" should be deemed to apply to any process for maintaining food for human consumption at such temperatures as will maintain it in its highest state of wholesomeness.

2d. The term "cold storage building" or "warehouse" should be deemed to apply to an establishment employing refrigerating machinery or ice for the purpose of refrigeration, or a room or building otherwise artificially cooled.

3d. The term "article of food" as used in cold storage regulations should be interpreted to include all articles of food, animal or vegetable, for human consumption, requiring any regulation of temperatures for their efficient sanitary preservation.

4th. No article of food should be placed in cold storage which is not mature, fresh, free from disease or deterioration of any kind, or in a condition such that, if kept under proper cold storage conditions it will be, when removed, wholesome and suitable for use as a food.

5th. It is essential that all foods possessing a temperature favoring some degree of deterioration should be cooled to a proper temperature as rapidly as possible with a view to maintaining it in its natural condition of freshness.

6th. After placing in cold storage it is essential to successful storage that the temperature and humidity found best for each particular food be maintained as evenly as possible.

7th. It is further essential that, with certain types of food products, circulation of air be maintained in the cold storage warehouse, and that an adequate amount of fresh cooled air be introduced each twenty-four hours; or, that the circulation air be passed through some solution depriving it of the volatile emanations of the food.

8th. Every storage warehouse should be constructed of such materials as will not cause organic emanations and in such a manner as will facilitate maintenance in as good sanitary condition as is maintained in the most modern plant employing the most modern methods for the preparation and handling of perishable food products.

9th. The periods of time during which food products should be allowed to remain in cold storage should depend upon their original freshness of condition, the continued maintenance of their optimum cold storage conditions and upon the results of further investigations on each class of food products.

10th. It is desirable that frozen cold storage food products be raised gradually to higher temperatures, varying according to the size and nature of the article of food, in order to preserve the tissues in their natural condition. (This may be done by the warehouseman, the retailer or the consumer.)

11th. Articles of food should not be returned to cold storage which have once been released and raised to materially higher temperatures. When it becomes necessary to transfer food products from one cold storage warehouse to another the temperature should not be allowed to rise to a point favoring deterioration. Articles of food removed from cold storage for consumption or sale and which, at the close of the day, remain unconsumed or unsold, may be returned, if in a wholesome condition, to the cold storage warehouse for temporary storage.

12th. In order both to maintain cold stored foods in the best condition possible and to preserve the credit of cold storage methods, it is essential that municipal control of foods placed in retail stores for consumption be of the most practical and scientific character.

HEALTH DEPARTMENT REPORTS AND NOTES.

REPORTS.

Augusta, Georgia.

Dr. E. E. Murphy presents his usual interesting report of the work of the Board of Health of Augusta during 1913. Augusta is a city with the usual southern problem of maintaining a generally healthy condition in the face of a large colored population which has no knowledge of or regard for sanitation and whose physicians are usually not as well trained as their white colleagues.

Augusta spends about fifty-four cents per capita on health work but has a general death-rate of 17.0 notwithstanding, and is unable to even reduce the white death-rate to any great extent on account of the negro element of the population as a potential fountain of infection. Of the total population of 51,000, it is estimated that 27,400 are white and 23,600 colored and the death-rates are: White, 13.7, colored, 20.0. Lack of complete reports of disease from the colored population are probably an added problem since the birth-rates (white, 21.3, colored, 9.8) are apparently incorrect. From figures given in the report of vital statistics, the table of death-rates per 100,000 is computed:

Cause of death.	White.	Colored.
Tuberculosis	87.6	233.0
Cancer	76.7	38.1
Pellagra	32.8	55.9
Malaria	11.0	38.1
La grippe	11.0	46.5
Pneumonia	124.1	262.3
Entero colitis	91.3	55.0
Nephritis	168.6	304.6
Diphtheria (case rate)	157.0	8.5
Smallpox (case rate)	7.3	88.8

During the past year the deaths of children under five years has been reduced from 221 in 1912 to 165 in 1913, a reduction which Doctor Murphy attributes to an improvement in the milk supply. Oiling for mosquitoes has been done on a larger scale during the past year and malaria has been reduced from 21 deaths to 9.

Recommendations for the coming year include the employment of district nurses for visiting cases of tuberculosis, the establishment of a tuberculosis camp, the building of several incineration plants for garbage throughout the city, the employment of additional inspectors of school children, and of an inspector for restaurants and groceries who is to be preferably a woman.

The report would be improved by the introduction of the international system of classification of deaths in place of the unstandardized alphabetical arrangement now used.

Summit, New Jersey.

Mr. Max J. Colton, former health officer of Summit, presents a very interesting report of the work of the health department of that city for the year of 1913. It presents the work in a very instructive and readable manner and is far better than the reports of many larger cities.

Although Summit had a population estimated as being only 9,300 in 1913 it is one of the New Jersey cities which have been leaders in public health progress and employs a full time health officer and registar of vital statistics and also a plumbing and sanitary inspector and a clerk. The expenditures of the Board of Health for 1913 were about $3 800 or about forty cents per capita. The value of this expenditure is plainly shown in the low death- and disease-rates, the excellent condition of the milk supply and elsewhere.

Among the various features of the past year's progress may be noted the moving of the office of the board to newer and roomier quarters and the establishment of a laboratory for the diagnosis of diphtheria, typhoid,

tuberculosis and malaria, as well as for the examination of milk and water. Clean-up week was successfully introduced with the aid of the school children and the Town Improvement Association. Public health instruction is carried on through the aid of one of the local papers which gives space each week for health department news and by a bulletin board where notices and other material are posted. Cards containing a list of health rules were also distributed to the school children.

Believing that the methods of disinfection after tuberculosis were not adequate as carried on, Mr. Colton sent out a questionnaire on methods to other cities and has issued the following recommendations:

1. Notify all owners of houses in which there is located cases of tuberculosis and make it compulsory for them to report to us in case of a removal.

2. Upon the removal of a patient the room or rooms occupied shall be thoroughly washed with hot water and soap. This shall include all woodwork, furniture, etc. If in the judgment of the Health Officer the walls need a more thorough disinfection than can be accomplished by fumigation, they shall be sprayed with a disinfectant. The rooms shall be thoroughly aired and dried before being used again.

3. Upon the death of a tubercular person the room or rooms shall be fumigated with formaldehyde. After that the entire premises shall be gone over and determined what further steps are necessary. This shall consist of thoroughly washing all woodwork, furniture, etc., with hot water and soap. The rooms that are papered should be given the same disinfection as after the removal of a patient. All material which cannot be made safe by disinfection shall be burned. The room or rooms shall be thoroughly aired and dried before being occupied again.

4. Disinfection shall be performed as heretofore, free of charge. The washing of the rooms shall be performed by the owner of the house or the tenant living in such house at the time of the removal or death of the patient, under the supervision of the Board of Health.

The milk supply is carefully controlled and appears to be in excellent condition; repeated inspections accompanied by instruction have brought about the following improvement in average dairy scores for the twenty farms supplying milk to the city. 1910, 66.50, 1911, 72.79, 1912, 77.94, 1913, 80.17. It is to be noted also that since 1910 only one death from diarrhea among children under five has occurred each year.

During 1913 the plumbing inspector acted as registrar of vital statistics and presents an excellent report.

DEPARTMENT NOTES.

Public Health Survey, Topeka, Kansas.

The investigations made by the Department of Surveys and Exhibits of the Russell Sage Foundation of the sanitary conditions of the various cities of the United States have had a profound influence in stimulating health work all over the country. Studies of this sort have been made by Mr. Franz Schneider, Jr., of the Department of Newburg, N. Y., Newark, N. J., and Atlanta, Ga., and other cities.

The report on the conditions in Topeka, Kansas, made by Mr. Schneider to the Topeka Improvement Survey Committee, has just come to hand, and this last report seems to the reviewer the best thing in this line that has yet been accomplished anywhere. The report takes up in detail conditions regarding life, death, and disease in Topeka; analyzing statistics in detail by wards.

Then follows a detailed discussion of sanitary conditions, water supply, sewage disposal (including an investigation of the condition of sewers themselves by Professor G. R. Jones of the State University), milk supply, food supply, wells and privies, and such special problems as tuberculosis, infant mortality, venereal diseases, housing, refuse disposal, and the physical examination of

school children. This section of the report is very fully illustrated by a most admirable series of photographs of local conditions; many of the pictures being destined to furnish classic examples for lectures and discussions of the topics in question.

Mr. Schneider then proceeds to analyze the organization and budget of the Department and to make specific recommendations as to the need for a properly qualified full-time health officer, and for radical improvement in the system of milk and food inspection; the extension of the work on communicable diseases, and the institution of comprehensive campaigns against tuberculosis, infant mortality and venereal diseases. He also emphasizes the need for organized work in public health education.

This report would be of value to all municipal health officers as a check upon the efficiency of their work.

C.-E. A. Winslow.

Coöperative Health Administration among Small Communities.

There is today in the practical public health field no more vital problem than how small towns and cities can, with their limited resources, obtain the expert health service which they require. One promising move toward a solution has been made in the recently adopted New York State plan by which a greater degree of supervision of state over local authorities is established. But, while this is still in the inceptive stage, a searching trying-out of the possibilities of coöperative maintenance of a joint health office has been going on in a group of Massachusetts towns. The successful results obtained in this experiment, the first noteworthy one of its kind, are reported in a paper by Earle B. Phelps in a recent number of *Public Health Reports* and summarized as follows:

"The local health office in the smaller communities is the most essential and least efficient part of the present-day public health machine. The highly specialized character of public health work and the financial inability of the smaller community to support a properly trained health organization are in large measure responsible for this condition.

"Consolidation of adjoining communities in a coöperative health office will provide a sufficient population to support the requisite minimum organization for efficient health work at a per capita charge much less than that usually imposed in the larger cities for work of a similar character.

"The details of such a coöperative effort inaugurated among certain Massachusetts towns by the officers of the department of biology and public health of the Massachusetts Institute of Technology are given.

"This work was assisted by the Surgeon General of the United States Public Health Service through the detail of a sanitary bacteriologist and through the devoting of a portion of the writer's time to the general supervision of the work since October 1, 1913.

"An organization comprising an administrative officer, a bacteriologist and secretary, a sanitary and plumbing inspector, a field assistant, and two clerks served a population of 32,650 in all departments of the work except plumbing inspection (a population of 8,385 being served) and an additional population of 30,000 in milk inspection and control, at a cost of $7,603.51 for the year.

"The output of such a health office can be increased by the appointment of assistants at less than a proportionate increase in maintenance costs.

"The prompt measures taken in the preliminary investigation of every case of contagious disease, backed up by the findings of the diagnostic laboratory, have, in at least two cases, prevented serious outbreaks of contagious disease and would undoubtedly have prevented a third outbreak and one death had they been in force in a neighboring town from which a carrier case was imported.

"The average bacterial content of the milk supply has been reduced by approximately two-thirds without any restrictive measures having been imposed upon the producers themselves other than those already in force. This has been done by a systematic laboratory control of the milk supply embodying monthly chemical and bacterial analyses, by a policy of publicity, and by helpful,

constructive criticism given to the producers upon request. The improvement is of especial significance in view of the generally good quality of the milk supplies in question. Starting with 32 per cent. of the individual supplies below 10,000 bacteria per cubic centimeter and 50 per cent. below 20,000, one year later 31 per cent. were below 5,000, 56 per cent. below 10,000, and 74 per cent. below 20,000.

"Prompt and energetic measures were adopted in the control of contagious diseases, every effort being made to locate the initial source.

"Campaigns for mosquito and fly suppression were carried through successfully.

"An accounting system, showing full details of the costs of this work, was employed. The work of the diagnostic laboratory and the milk inspection and control cost approximately 3 cents per capita per annum each, and the work of sanitary inspection and control of contagious disease cost slightly more. The total cost of the work, exclusive of plumbing inspection, was 19 cents per capita per annum.

"A population of about 60,000 would develop each of the various subdivisions of the work to a point of maximum efficiency and could support the work of a complete organization, including two district nurses and medical and veterinary advisory services, at a per capita cost (exclusive of plumbing inspection) of one-half the average cost of board of health work in the large cities of the United States.

"Such a coöperative office may be organized among the towns themselves, through the initiative of State or educational authorities, or under the direction of a consulting sanitarian, or it may be conducted entirely by an outside consulting office specializing in public health work."

The equipment and duties of a local health office, the problems of local administration, and the minimum requirement of such an office are discussed at some length, and the year's work under a permanent organization is reported upon in detail, with analysis of costs. Appendices giving the form of agreement adopted and a list of the necessary laboratory equipment for a small board of health laboratory are added.

Such a coöperati ve plan, it may be added does not necessarily imply the consolidation of town interests in any other respect than that of public health, or even complete consolidation in that.

This important paper is printed in *Public Health Reports* for September 25, 1914, copies of which may be obtained from the United States Public Health Service, Washington, and should be carefully read by all health officers and others interested in local health administration, for its analysis of needs and methods as well as for its account of the coöperative plan.

Putting a Stop to Bathing in Sewage.

One of the problems of a large city like New York, is to provide suitable bathing places where particularly the poor of the city may enjoy the refreshing benefit of a bath during the hot weather. The following clipping taken from *Survey* for July 25, 1914, outlines the method taken by the New York City Health Department.

"In many quarters the stand against New York city's encouragement of bathing in polluted river waters has been crystallizing. The last of March an order was issued by Commissioner Goldwater, of the Health Department, forbidding the use of the floating baths within a danger zone bounded by the Narrows, the waters of the Hudson and Harlem, and East River below the Bronx Kills.

"Immediately the owners of private river baths, entrenched behind city permits and leases, raised a hue and cry. In deference to their protests a hearing was held by the Health Department.

"Following this, the order of the Health Department was somewhat modified. An amendment to the sanitary code granted permission to continue river bathing, public and private, provided that the hitherto more or less complete enclosures of river or harbor waters be made entirely water tight; that no river or harbor water be used unless purified; that persons suffering from communicable diseases be excluded and that all bathers be

required to use a shower bath before entering a pool.

"In order that the million and a half bathers who enjoyed river bathing in the floating baths last summer may not be deprived, the Bureau of Public Buildings and Offices of the Department of Public Works, at the request of the borough president, has arranged to remodel six of the public floating baths so that they will be water-tight. Into these Croton water will be introduced. Salt may be added.

"One hundred and twenty-seven sewers empty into the Harlem and East Rivers, and sixty-two empty into the Hudson from Manhattan alone. Chemical and bacteriological examinations have repeatedly shown the water to be highly polluted. The 500,000,000 gallons of sewage daily discharged into the waters surrounding Manhattan face the further unhappy prospect of some 150,000,000 gallons of the Passaic Valley sewage from New Jersey soon to be added daily to the waters of New York."

Following Up Malaria Cases.

To make the line of defense against malaria more complete, Charles F. Mason, Chief Health Officer of the Canal Zone, has had the following notice posted prominently throughout the district:

"1. Patients suffering from malaria often retain the germ of the disease in their blood after all the symptoms have disappeared, so that they are apparently well. Such cases are a danger to the community, in that they infect the mosquitoes and through them other people. Besides this, such cases are not permanently cured and will relapse whenever their resisting power is lowered from any depressing cause.

"2. As patients naturally do not desire to remain in hospital after they feel well enough to work, it is necessary that they should continue under treatment in quarters until they are permanently cured. It is, therefore, directed that employees suffering from malaria shall, when discharged from the hospital, report to their district physician for treatment, and shall continue to report for treatment for at least one month and until pronounced cured.

"3. Any employee who wilfully fails to comply with this regulation shall be suspended without pay, or be discharged from the service.

"4. Heads of departments and divisions, hospital and district physicians, foremen and others concerned, are directed to do all in their power to assist in enforcing this order."

A similar measure would be desirable in many parts of this country but would be difficult to enforce since even at the Isthmus with its fairly rigid government control it is found that many of the lower class of laborers fail to report as directed.

Canal Zone Health Department.

The *Canal Record* of August 12 publishes the following order, just issued by Governor Goethals of the Canal Zone, providing for the future organization of the Health Department:

"1. The Health Department, under the supervision and direction of the Chief Health Officer, is charged with all matters relating to maritime sanitation and quarantine in the ports and waters of the Canal Zone, and in the harbors of the cities of Panama and Colon and with land sanitation in the Canal Zone, and sanitary matters in said cities, in conformity with the Canal Treaty between the United States and the Republic of Panama, and existing agreements between the two Governments thereunder, and all matters relating to hospitals and charities.

"2. The Health Department is subdivided, as follows: (a) Division of Hospitals and Charities, (b) Division of Sanitation, (c) Division of Quarantine.

"3. The Division of Hospitals and Charities is under the direct supervision of the Chief Health Officer. Included in its jurisdiction are such hospitals as may from time to time be established in the Canal Zone, the Santo Tomas Hospital in the city of Panama, such institutions as the Palo Seco leper asylum, the Corozal farm, and any other institutions that may be established by proper authority, and such dispensaries as are or may be found necessary.

"4. The Division of Sanitation includes the Division of Zone Sanitation and the health offices of the cities of Panama and Colon:

"(a) The Division of Zone Sanitation is under the direct charge of the General Inspector, who will perform the duties heretofore assigned to the Chief Sanitary Inspector and to the General Inspector. He shall have direct charge, management, and control of all work performed or entered upon within the Canal Zone for the prevention or suppression of diseases. He shall be charged with the duty of securing the enforcement of all sanitary regulations, and perform such other duties appertaining to his position as may be required by the Chief Health Officer or the Governor of The Panama Canal.

"(b) The Health Officer of the city of Panama, under the supervision and control of the Chief Health Officer shall enforce the sanitary rules and regulations in force in said city, and shall perform such duties as may be prescribed by law, and also such other duties appertaining to his office as may be required of him by the Chief Health Officer or the Governor of The Panama Canal.

"(c) The Health Officer of the city of Colon, under the supervision and control of the Chief Health Officer, shall enforce the sanitary rules and regulations in force in said city, and shall perform such other duties as may be prescribed by law, and also such other duties appertaining to his office as may be required of him by the Chief Health Officer or by the Governor of The Panama Canal. His territorial jurisdiction shall extend to and include the municipality of Cristobal, in the Canal Zone, and such areas in the vicinity thereof as may be assigned to him by the Chief Health Officer.

"5. The Division of Quarantine shall include the quarantine stations of Balboa-Panama, Cristobal-Colon, and the quarantine inspection at Bocas del Toro. It shall be under the direct charge of the Chief Quarantine Officer, who shall have charge of the sanitation of the harbors and vessels lying therein, and shall see that such measures are enforced as are necessary for the proper hygiene of vessels, their cargoes and personnel, whether in port or *en route*, and to prevent the vessels from being a source of danger to other vessels or to the port; he is authorized to certify bills of health to vessels clearing from ports under his jurisdiction, setting forth in such bill of health the conditions of the port, vessel, cargo, passengers, and crew; he is authorized, at the request of the master of any vessel, to disinfect and otherwise place such vessel in a sanitary condition, so that it may leave the port in free *pratique*, and be able to make entry at the port of destination without further disinfection or detention in quarantine; he shall prevent the entry into the Canal Zone of any person whose presence would be a menace to the public health or welfare, or who would be liable to become a charge upon the public."

Coöperation Between City Governments and Universities.

In view of the discussions, held before the American Public Health Association in 1910 and reported in this JOURNAL, on the subject of coöperation between state boards of health and state universities, the following suggestion made by Professor Jeremiah W. Jenks of New York University, and taken from the October *National Municipal Review*, is of interest. The occasion was a recent conference in New York on the universities and training for public service. While the remarks bear specifically on city government, they obviously have a more general application.

"Beyond the work that may be done by professors and experts, it has been suggested that there may also be helpful coöperation on the part of advanced students. Beyond any question, graduate students who are fitting themselves for positions in public administrative work would be greatly benefited if, in addition to their lectures and reading, they could have some actual practice in administration. They would often be glad to secure this practice, either at no expense to the city, or for the payment of merely a minimum living salary while they are getting their training. If two students were to work together in this way, dividing the time between them,

they could arrange to take the work of one position in the city government, each receiving half-pay for his half-time work. If the positions thus filled were those that would give the students an insight into the principles of government and give them the opportunity for constructive work, it would be of great importance to them. Moreover, the city would doubtless be able to secure in this way a higher grade of work—properly supervised also by the university professor—than they would get from the ordinary employee. It is hoped that some plan like this can be worked out."

Classes for the benefit of city employees under civil service rules, clubs of graduate students for study of municipal problems, and civic information bureaus in connection with such clubs are also suggested.

Kentucky Health Officers' Conference.

That the preventable disease of typhoid fever costs the State of Kentucky more than the amount of money required to run the State Government, was brought out at the recent Health Officers' Conference in that State.

With the assistance of the United States Public Health Service a most vigorous campaign of education and treatment has been waged against trachoma especially in the mountainous parts of the State where its prevalance is most alarming.

The conference outlined plans for a thorough study of pellagra during the coming year. There are a number of cases in the State and one death has been reported in Louisville during the past year.

Prophylactic measures against the possible invasion of river cities by plague-infected rats from New Orleans were also advocated. All the State health officers were in favor of a war on rats.

Nevada Service Reorganized.

A recent circular announces the reorganization of the service in the State Hygienic Laboratory of Nevada. Since its founding in 1909 the laboratory has confined its activities almost entirely to the diagnosis of the more prevalent infectious diseases, but now comes the announcement of a practically new department for "assistance in the prevention and control of communicable diseases within the State." "Scattering work" has been done heretofore along this line but arrangements have now been made to give this work special attention.

Stock vaccines will be distributed without charge and autogenous vaccines made up on occasion. Public water supplies will be analyzed free, sewage pollution investigated and recommendations for sewage disposal systems given. A specialty will be made of epidemiological problems, especially in regard to milk supplies.

All of this work will be free to the people of the State with the exception of traveling and other expenses of the collector or inspector when the services of such a person are needed.

Enforcing Sanitary Laws.

"What is true of laws in general is equally true of sanitary laws. Many so-called sanitary and public health laws now on our statutes are an obstacle to progress in preventive medicine. Many good sanitary laws are not enforced and cannot be enforced because public sentiment is not fully alive to the importance of preventive medicine. The natural result of this apathy is a withholding of proper authority and proper appropriations by means of which laws can be enforced. Hence, laws fail in their purpose. One of the greatest needs in efficient public health work in the United States is a national Department of Health, a great central educational institution for research, for information, for coöperation. There must be a well-organized national health department in which must center every function of the government in any way touching public health. The aid and coöperation of this department must be available to every citizen, every community and every city and state board of health in all public health problems, even as the aid of a national Department of Agriculture is now available to every farmer and every farming community."

Jour. Indiana State Med. Assn.

Midwifery in New York City.

In the July number of the *Monthly Bulletin* of the Department of Health of the City of New York there appears an article by Dr. Rosalie Bell on the work done in the supervision of midwives in New York City. Up to 1907 there was no supervision or investigation of the midwives. All that was necessary was to file a certificate of moral character and experience, properly signed, with the Registrar of Records, and the midwife was free to practise. For years this method worked successfully. But as the character of immigrants changed so did the type of midwife, and soon there were many wholly unfit women practising midwifery among the foreigners. Many of these women had little or no training in midwifery and the Department of Health decided that steps should be taken to supervise and control midwives.

The law of 1907, Chap. 432, gave the Department power to supervise and control midwifery, and in November, 1907, the Sanitary Code was amended to the effect that no midwifery was to be practised or no lying-in-hospital was to be conducted without permit from the Board of Health.

In 1909 the supervision of midwives was given to the Bureau of Child Hygiene. All known midwives were visited and asked to call at the Department office and apply for a permit to practise. The application was signed and endorsed by two physicians and a layman and was sent to the Bureau of Child Hygiene. A medical inspector called on the midwife and made a thorough inspection and investigation. If conditions were found satisfactory the medical inspector signed the application and returned it to the Department. The midwife was then granted her permit for one year, together with a book of rules and regulations, and also a supply of silver nitrate solution to be used according to the rules. Monthly inspection by a Department nurse was made, and at the end of the year the same procedure was again gone through.

In 1913 there were 1,344 licensed midwives in New York City, largely from the midwifery schools in Europe. In 1911 a free training school for midwives under municipal control was established. The course given extends over six months and it gives a thorough training. Diplomas are awarded.

On January 1, 1914, a set of rules and regulations was adopted by the Board of Health, stating the general conduct of the schools, requisites for entrance, instruction and courses of study, and recognition of schools outside of New York City.

PUBLIC HEALTH NOTES.

Economic Causes of Disease.

The intimate relation existing between economic conditions and disease has been reëmphasized by Surgeon-General Wm. E. Gorgas, who in a recent address in Cincinnati declared out of his own experience that poverty is "the greatest single cause of sad sanitary conditions." The solution, in his opinion, lies in the adoption of single-tax, through its effect in eliminating the poverty due to inequitable distribution of wealth. "Sanitation, in my mind, has been very closely associated with single-tax. . . . Sanitation is most needed by the class of people who would be most benefited by the single-tax."

The effect of such a tax reform in eliminating neglected property is another argument. "In a city such as Panama or Havana, the vacant lots and unimproved neighborhood were the localities which always gave us most sanitary trouble. I was soon convinced that if any scheme were brought about whereby it would be disadvantageous for speculators to hold vacant places out of use, this scheme would be of the greatest value for sanitation. . . . I discussed this method of taxation a good deal with the officials of Panama, urging upon them the desirability of a tax levy of this kind to cover expenditures brought about by the sanitary work. . . . I hope that something of the kind may yet come about in Panama."

Every health officer can testify as to the difficulties arising in connection with properties such as those described, and welcomes any light on methods of dealing more satisfactorily with them. Aside from the possible merits of the solution proposed, the remarks are suggestive and bring out anew the interrelationship of the public health movement with social and economic conditions, in the solution of which the Health Officer has a vital interest.

The Fly at the Bar.

Boards of Health, National, State, and local, have issued rules and warnings against the house-fly, until "Swat the fly" has become a household injunction, although not always in such unconventional terms. We believe that it has remained for England to be the first to bring this domestic pest before the bar, and that this year he (or she) has for the first time been arraigned in court. A recent number of the London *Times* devotes a column to this, which may well become a standard case, to which reference will be made by judge and lawyer.

It seems that in a hamlet on the Thames a market gardener deposited stable manure on land adjoining the residence of a Mrs. Bland. This lady and her husband had the courage to test the right of the gardener to maintain a nuisance of this kind on his own premises. The courts held that while a disagreeable smell might not be cause sufficient to justify an injunction, the fact that flies breed in manure and might injure the health of neighbors was full justification for an order of restraint.

The case afforded an opportunity for rival experts to give partisan evidence. One of them for the defendant testified that the gardener managed this manure well, that it gave off only "quite an agreeable smell of ammonia." Of course he saw no flies! Another expert from the British Museum also testified for the defense that he did not see any flies on the gardener's premises, but found a swarm of flies on the porch, belonging to three or four different species, with no single house-fly. He admitted that house-flies bred in manure, but was unwilling to testify that the people in the house were justified in claiming a menace to health or even discomfort.

The judge stated that the complainants had proved that flies had been prevalent ever since the manure had been placed where it was, necessitating wire screens in the windows; that the flies came from the manure; that experts had discovered an abnormal number of flies, and that they were not only a discomfort but might be a menace to health; and, although he felt reluctant to interfere with the gardener's profitable industry, he

felt compelled to grant an injunction restraining him from so handling his stable manure as to make possible the breeding of flies near adjoining premises, and he assessed the costs of the suit against the defendant.

Outlook, August 29.

Rural Sanitation.

"The following suggestions are offered as indicating hopeful lines of work:

"(1) The granges of the state offer the most attractive possibilities in this direction and a health officer could find pleasant and useful employment at their meetings.

"(2) There should be coöperation with the rural school superintendents and discussion of sanitary matters in the various schoolhouses.

"(3) Instruction may be given to the children of the country schools by their teachers after the latter have been properly posted by the health officer on the subjects upon which they should be informed.

"(4) The health officer can occasionally work with the pastor of the rural church, addressing the people on sanitary matters, on suitable occasions, at the church.

"In all these points the department of health is only in line with the tendencies of the times when it attempts to give to rural inhabitants the same advantages with regard to public sanitation which are enjoyed by the cities."

American Review of Reviews.

Bactericidal Floor Covering.

The *International Hospital Record* of August 25 contains the following note on linoleum as a sanitary floor covering, clipped from *Die Umschau* (Berlin):

"In testing for germs it is often found that such substances as stone, wood, porcelain, glass, etc., are sterile. A number of years ago Privy Councilor E. Fischer made the observation that on certain building materials disease germs quickly die. L. Bitter has shown that the very resistant staphylococcus perishes within one day on the surface of linoleum. As far back as 1901, Jacobowitz proved that the germ-killing effect of the much-acclaimed 'disinfecting wall-paints' was due to the chemical effect of the linseed-oil used as a binding medium. Since the essential constituents of linoleum are cork and a large quantity of linseed-oil, its disinfecting capacity is not to be wondered at. But in the case of the disinfecting wall-paints the sterilizing power wears off in a few months because the linseed-oil dries, while linoleum has a lasting effect. Hence linoleum operates to kill the majority of the microörganisms brought in on the shoes. Frequent moistening accelerates this disinfecting property. Hence, all disease-germs which do not form spores quickly die on a linoleum covering which is wiped off daily with a damp cloth. According to F. Fritz this bactericidal power is due to certain chemical groups in the oil, especially linoxyn."

A Scheme to Preserve Infant Life.

"A number of interesting proposals have recently been brought forward by the Women's Coöperative Guild for ensuring a better start for new generations by helping prospective mothers. The reforms suggested are: (1) To make the Notification of Births Act, now applied to about 60 per cent., compulsory for all the community. (2) To establish maternity centres, under the local authorities, for the organization of instruction and help. (3) To appoint municipal midwives. (4) To transfer maternity benefits from administration under the Insurance Act to the control of local authorities. It is estimated that an annual saving of 50,000 lives is being effected on our infant mortality-rate. It is variously estimated that out of the 25,000 blind people in this country, 60 to 80 per cent. have become blind from opthalmia neonatorum, which is a curable disease if properly treated. Now that this is a notifiable disease, it is hoped that Public Health Authorities will take steps to bring the necessary relief. Quite recently the Bradford Town Council opened a model little hospital for the treatment of opthalmia neonatorum and the operative and more expert treatment of the eye, ear, throat and nose. In an investigation of about 700 cases,

it was found by the London County Medical Officers that in nearly one-half, mental deficiency was due to pre-natal and birth conditions. Maternity and pregnancy sickness should be removed from the Insurance Act and placed under the Public Health Authority. It is suggested that a grant equivalent to £7 10s. for every child born should be made by the State to all mothers under the £160 income limit. The mother should draw £5 of this benefit. She might be given her choice of £1 10s. in cash at confinement, or if she employed the municipal midwife, £1 in cash and free midwife, the remaining sum to be paid in weekly instalments. The further sum, averaging £2 10s. per birth, would form a fund from which additional benefit might be given. The health and general welfare of its children should be the greatest asset of the community and ought to be its first care."

Journal of State Medicine, August.

Water Filtration for Detroit.

"Theodore A. Leisen, who has just assumed his new duties as the chief engineer of the water works of Detroit, Mich., states that the next great improvement needed in the system is a filtration plant, the cost of which, for the 200,000,000 gallons a day capacity required, he estimated at $2,000,000 to $3,000,000.

"Detroit is now using hypochlorite to some extent, but Mr. Leisen does not consider it a substitute for filtration, but rather as a supplementary treatment. He also recommends sewage purification for the city.

"Mr. Leisen comes to Detroit from the Louisville water works, of which he has been superintendent and engineer for several years, and he succeeds Geo. H. Fenkell, who was appointed commissioner of the department of public works some months since."

Municipal Engineering, July, 1914.

New Problems of Public Health.

The Prudential Insurance has recently published a pamphlet entitled "The Chances of Death and the Ministry of Health," by Frederick L. Hoffman. This was an address delivered before the Yale Divinity School, March 30, 1914. The following is of interest:

"With the passing or control of the diseases which have become common knowledge, new ailments and afflictions cause new problems of serious importance, because the conditions of spread are either entirely unknown or but imperfectly understood. Influenza is one of these diseases, which, within recent years, appeared for the first time as a national scourge in 1891, causing directly or indirectly an enormous loss of life, and the disease has since prevailed to a more or less extent, either pneumonia, accounting for 6.1 per cent.; and cancer, accounting for 5.6 per cent. These six causes alone are responsible for 38.8 per cent. of the entire mortality. Other diseases, now largely under control but intrinsically as serious a menace to community life as any of those mentioned, are typhoid fever, smallpox, measles, scarlet fever, whooping cough, diphtheria, etc. The typhoid death-rate, which is typical of sanitary progress or neglect, has declined in American cities from an average of 51 per 100,000 of population during the decade ending with 1892 to 25, or just about one-half, during the decade ending with 1912; but our typhoid fever rate is still excessive and no cause of death perhaps illustrates better the lamentable amount of still existing municipal neglect. Tuberculosis, the foe of mankind for ages, the disease par excellence, considered a visitation of God, has, during the last generation, been brought within the range of human control, with a fair prospect that within a measurable period of time its ravages will be reduced still more than has been the case in the recent past. The tuberculosis death-rate of American cities during the decade ending with 1882 was 318 per 100,000 of population, but the rate during the last decade was only 182. Within more recent years the mortality from smallpox has been reduced from an average of 3.4 during the five years ending with 1905 to a rate of only 0.3, or about one-tenth of the earlier rate, during the year 1912. The mortality from the dread diseases of infancy, diphtheria and croup, has been reduced from an average of 29.6 during the five years ending.

"The conservation of human life and health, or, as said by Prof. Irving Fisher, the problem of life extension, is not only of economic, but also of great moral significance. The perfection of human character is, partly at least, conditioned by the maximum attainable duration of life, and old age is an essential to human development, moral and spiritual, as is the secular and religious education of youth."

The Duck as a Preventive Against Malaria and Yellow Fever.

The duck enters a new field of usefulness: namely, that of destroying mosquito larvæ, and consequently acts as an eradicator of mosquito-carried diseases. Samuel G. Dixon, M. D., LL. D., in the October 3 number of the *Journal of the American Medical Association* describes experiments which he conducted to demonstrate this fact. For this purpose he employed Mallard ducks and his reports testify as to their ability in this field of public health service.

After unsuccessful attempts in which fish were employed to destroy the larvæ, the stream where the experiments were being carried on was divided into two parts. Each portion covered an area of about 1,400 square feet. The conditions created were ideal for mosquito breeding. One pond was protected from the birds and was stocked with gold fish. The other pond was the feeding ground of the fowl for months. Mosquitoes flourished in the protected pond, while the unprotected one was entirely free from the insects.

Ducks were now introduced into the protected area. At first the varied food in the form of tadpoles tempted them; but inside of twenty-four hours they had rid the pond of pupæ; and in forty-eight hours only a few small larvæ remained. The author states that numbers of larvæ must have been drowned, due to the commotion of the water produced by the birds. Doctor Dixon says, "For some years I have been using ducks to keep down mosquitoes in swamps that would have been difficult and expensive to drain, but I never fully appreciated the high degree of efficiency of the duck as a destroyer of mosquito life until the foregoing test was made."

As further proof of his belief and work Doctor Dixon points to the work of Howard, Dyar, and Knab, "Mosquitoes of North and Central America," advancing the theory that ducks destroy mosquito larvæ. Mr. William Lockwood, of Boston, an artist, expresses the same idea; while Mr. McAtee of the *Biological Survey* voices the same opinion.

Infantile Paralysis.

The July number of the *Journal of Infectious Diseases* prints the account of an unsuccessful attempt to transmit poliomyelitis by the bite of Lyperosia irritans, a blood-sucking fly often found in great numbers on cattle. Because of the successful transmission of the disease from monkey to monkey by Stomoxys calcitrans as reported by Roseneau and others it was natural that Lyperosia should be regarded with suspicion. Experiments were accordingly begun with this fly in August 1913 by Edward Francis at the United States Marine Hospital in Savannah, Ga. But, although the flies were allowed to feed alternately upon diseased and fresh macacus rhesus monkeys for several days, no transmission of the disease was thereby effected.

Cytology of Milk.

The study of the cellular content of milk is discussed at some length in the *Journal of Pathology and Bacteriology* for July, 1914, by G. S. Woodhead and P. C. V. Jones. Their careful investigations in this comparatively unexplored field demonstrated the existence of eleven types of cells in the lacteal fluid. Of particular interest to the sanitarian is the discovery of blood cells in normal milk. We quote their concluding paragraph:

"The presence of blood cells, sometimes in large numbers, in the milk is of special importance in view of the recent observations on the presence of the tuber.le bacillus in the circulating blood of cattle. It would appear to explain the infective character of milk of tuberculous cattle in which not the slightest lesion can be found in the udder."

Septic Sore Throat and Infected Milk.

Additional information concerning an epidemic of streptococcus sore throat coincident with that which occurred in Chicago in the winter of 1911–12 is given in an article by J. A. Capps and D. J. Davis in the July issue of the *Journal of Infectious Diseases*. The Chicago epidemic, it may be remembered, was traced to one dairy and on its farms cases of mastitis in the cows and cases of sore throat among the milkers were discovered.

The coincident epidemic at Batavia differed from that in Chicago in that the disease spread among the users of the milk of dairies other than the one on which the only combination of sore throat and mastitis was discovered. The evidence seemed to show, however, that this one farm was the only source of infection and that the general spread of the disease was due to the exchange of milk bottles by different dairies through the medium of their customers and the use of these bottles again without sterilization.

Being thus led to believe the combination of mastitis and sore throat on the same farm to be good evidence of infected milk, the above-mentioned authors sought and found such a combination of conditions. And upon following this milk to its consumers in Oak Park they discovered that an epidemic of sore throat was undoubtedly resulting from its use.

The same authors also publish in the magazine mentioned the record of certain experiments to test out the relationship of sore throat and mastitis, which seemed to be caused by the same organism. It was found that streptococci of human origin, whether injected into the udder of the cow with a catheter or gaining entrance through the injured surface of the teat, would immediately cause mastitis and consequent infection of the milk although there might be no physical evidence of the disease. Nor were the cultural or pathogenic properties of the streptococci changed after growing in the udder of the cow for weeks.

The Swimming Pool.

The July number of the *Journal of Infectious Diseases* takes up the problems of the swimming pool in an article by Wallace A. Manheimer in which the author gives an account of a detailed and extended study of the College, Association and Public swimming pools of the city of New York. We quote in part from the general recommendations which his investigations have led him to make:

"Pools should be constructed of smooth lining without crevices and should be of as large capacity as possible. There should be no obstructions of any kind in the water, a combination life rail and overflow ledge making this possible. Where feasible, the plunge should be constructed on the top floor so that the water used for flushing purposes could be taken from it. The fresh water usually employed for this purpose should be added to the pool instead. Each establishment should be provided with adequate shower baths and convenient dressing rooms and toilets.

"The water used in swimming pools should be pure. Where this is not possible it should be thoroughly purified before use by the methods indicated.

"The water should be thoroughly filtered before passing into the tank so that the opacity of the water could not obscure a submerged person.

"Refiltration is an efficient and economical method of keeping water clear during protracted use.

"Calcium hypochlorite, used in amounts controlled by appropriate test, has been shown to be efficient for the disinfection of swimming pool water and in conjunction with refiltration is urged as the most effective method of pool sanitation.

"Students and patrons should be subjected to physical examination before entering the plunge, and all diseased persons excluded. A set of rules should be given governing the important items of sanitary conduct in the water, *e. g.*, the importance of showering before and after bathing, the importance of taking sitz showers with soap, of abstaining

from expectorating in the water, the importance of emptying the bladder before entering the water, etc. Patrons and students should be compelled either to bath nude, or to use clothing the cleanliness of which has been approved by the director."

Housing in Six Cities.

The field secretary of the National Housing Association, Mr. John Ihlder, reviews in the *National Municipal Review* for October the reports on housing conditions in six American cities, each of which, he says, may be regarded as typifying the cities of its section. These are: Cambridge, Mass., Philadelphia, Richmond, Va., Los Angeles, Cal., Grand Rapids, Mich., and Cleveland, O. One of the reports sets out with the definition that "a housing problem may be said to exist wherever persons dwell under conditions dangerous to health, safety, and morality." While the reports reveal chiefly bad housing conditions, progress is also recorded, representing in these particular instances the beginning of the housing movement. The revelations made are designed to awaken an uninformed community to a realization of the facts. The publication of the Grand Rapids report was followed by an agitation for municipal regulation which resulted in the appointment of a housing council. Eventually there was drafted and adopted a housing code which the writer declares is at present the best in the country. An illustrated pamphlet by Miss Mildred Chadsey, chief of the Cleveland Bureau of Sanitation, on the housing conditions of the workingmen in that city, also comes in for commendation by the reviewer, who concludes: "It would pay other cities to measure themselves by Cleveland and learn whether they can equal its best and whether they do not exceed its worst."

Pure Milk Gains.

Pure Milk is making gains all over the country. *Public Health Reports* for May 15, 1914, contains a tabulation of bacterial standards in about 150 cities of the United States, having an aggregate population of about 21,000,000. Only a few years ago cities having bacterial standards were few and far between. The Housewives' league of Providence, R. I. (*The Survey*, Apr. 4, 1914), after a fifteen months' campaign which is said to have disclosed much dirty milk and some graft, and after being defeated in the city council, secured state legislation which transferred the control of the milk supply from a political milk inspector to the superintendent of health. St. Louis, Mo., through its municipal assembly, has adopted a new milk ordinance (*The Survey*, May 16, 1914) which places the granting and revocation of milk permits in the board of health and, besides other sanitary requirements, provides that after one year from date all milk sold in St. Louis must either be from cows (dairies?) which have been inspected and approved by the Board of Health or else must be pasteurized by the "holding method."—The supreme court of Illinois (*Koy* v. *Chicago*, Feb. 1914) has upheld a provision of a Chicago ordinance which requires milk to be pasteurized and lays down conditions of pasteurization.

M. N. Baker, in *National Municipal Review*, October.

PERSONAL NOTES.

The following persons were elected to membership in the American Public Health Association, during October.

OCTOBER 8.

George O. Adams, Lawrence, Mass.
Albert W. Buck, North Adams, Mass.
R. W. E. Cole, M. D., Arlington, Mass.
Wallace Payton Crigler, Ocala, Fla.
Haven Emerson, M. D., New York City.
William Haine, Hartford, Conn.
Ethel Lyon Heard, M. D., Galveston, Texas.
Stephen Russell Mallory Kennedy, Pensacola, Fla.
Friend Lee Mickle, Hartford, Conn.

Stanley H. Osborn, M. D., Cambridge, Mass.
Philip S. Platt, New York City.
Carl Frost Raver, M. D., Grand Forks, N. D.
Godfrey Leonard Alvin Ruehle, Geneva, N. Y.
R. H. Simmons, M. D., Shamokin, Pa.
George D. Troutman, M. D., Tucson, Ariz.
George B. Zimmele, Brookline, Mass.

OCTOBER 20.

George Ethan Adams, Milwaukee, Wis.
Lawrence Vreeland Burton, Urbana, Ill.
Mrs. Robert Goodhue Clarkson, New York City.
Henry Burdett Cleveland, Albany, N. Y.
Georgia Elizabeth Fleming, Urbana, Ill.
James W. Glover, Ann Arbor, Mich.
Stephen John Hauser, Cincinnati, Ohio.
William Duke Hayes, Jacksonville, Fla.
Grahem E. Henson, Jacksonville, Fla.
William Leland Holt, M. D., Jacksonville, Fla.
Charles Alpha Howland, Albany, N. Y.
Clarence Guy Lane, Woburn, Mass.
James F. McKinstry, Jr., M. D., Gainesville, Fla.
John MacDiarmid, M. D., DeLand, Fla.
Oliver Joseph Miller, Sanford, Fla.
Frank C. Perry, M. D., Jacksonville, Fla.
Charles Herbert Purdy, Jacksonville, Fla.
James Knox Simpson, Jacksonville, Fla.
Joel Andres Sperry, 2nd, Urbana, Ill.
Robert Victor Story, Middletown, Conn.
Edward Stuart, West Pownal, Maine.
Edward L. Wagner, New York City

OCTOBER 24.

Clarence Mulford Baker, Albany, N. Y.
Walter Jay Carpenter, M. D., Katanah, N. Y.
Edward Clark, M. D., Buffalo, N. Y.
Grover S. Cox, M. D., Tabor, N. C.
Clarence Christian Craft, Florence, S. C.
Guy C. Emerson, Boston, Mass.
Wm. Turner Fowles, Glenside, Pa.
Maurice Eby Heck, St. Augustine, Fla.
Leroy Watkins Hubbard, Mt. Vernon, N. Y.
Frank G. Jones, Indianapolis, Ind.
Charles A. LaMont, Canton, Ohio.
Calvin Gates Page, M. D., Boston, Mass.
Francis LeJau Parker, Ph. D., M. D., Charleston, S. C.
Alexander Potter, New York City.
Harry O. Sappington, M. D., Galveston, Texas.
Herbert Hector Utley, Smithfield, N. C.
E. Van Hood, M. D., Ocala, Fla.
Philip Van Ingen, M. D., New York City.
Willie Joseph Vinson, M. D., Tarpon Springs, Fla.
John Morris Weiss, New York City.
Wesson & Booker, Inc., Columbia, S. C.

OCTOBER 31.

Joseph M. Ayras, Bennington, Vt.
Alfred William Balch, Boston, Mass.
Richard Olding Beard, M. D., Minneapolis, Minn.
Charles White Berry, M. D., Brooklyn, N. Y.
William Merriam Cobleigh, New York, Mont.
Willard Joseph Denno, M. D., New York City.
James Hugh Finch, M. D., Champaign, Ill.
Frederick H. Gebhardt, M. D., Rutland, Vt.
D. Greenberg, New York City.
Murray Philip Horowitz, New York City.
James M. Jackson, Miami, Fla.
Henry Abner Ladd, M. D., Burlington, Vt.
Robert D. Luster, M. D., Granite City, Ill.
Jeanette Marks, South Hadley, Mass.
E. A. Moree, New York City.
Carl Shepard Oakman, M. D., Detroit, Mich.
John Albert Robison, M. D., Chicago, Ill.
Henry C. Sherman, New York City.
Henry Crain Tinkham, M. D., Burlington, Vt.
Wm. Alexander Womer, New Castle, Pa.

INDUSTRIAL HYGIENE AND SANITATION.

Regulations for the Prevention of Accidents in Foundries of Great Britain.

The regulations given below were compiled and recommended by the Home Office of Great Britain as a result of the conferences recently held at Manchester (England), between the Factory Department, represented by the superintending inspectors of each division, the inspector for dangerous trades and other inspectors, and representatives of associations of foundry employers and operatives.

"Where iron plates are used in moulding shops, either as gangways or under furnace spouts, they should be kept dry.

"Where molten metal has to be carried by hand between rows of boxes, a clear passage way, not less than 18 inches in width, should be maintained.

"Where molten metal has to be carried across an open space, a clear passage way, dry and covered where practicable, should be provided between the cupola and the place where the casting takes place; provided that it should not be deemed to be practicable to erect a covered way, if to do so would interfere with operations necessarily carried on in intervening space.

"No person under 16 years of age should carry molten metal.

"All chains used for lifting or moving any material should have been tested and should be periodically examined. They should be effectually softened by annealing or firing when necessary, and half-inch or smaller chains in general use should be re-annealed or fired once at least within every six months.

"Chains to which new links or rings have been added should not be used until they have been re-tested.

"A register should be kept on the premises, containing the distinctive mark or number of each chain, the date of the test, the test load, the safe working load, and the dates of annealing.

"First aid dressings for wounds or burns should be provided and kept at the factory.

"Adequate protection for the feet should be provided and maintained in proper order and repair, for the use of all persons employed in any part of a foundry where molten metal is caught, carried or poured. It should consist either of closely fitting boots constructed without lace holes or other openings in which molten metal can lodge, or of spats, flaps, or other appliances fitting closely above the ankles and covering all such openings in the boot, shoe, or clog worn by the worker.

"Every person employed in any part of a foundry where moulten metal is caught, carried, or poured, should, while at work, constantly wear the protection for the feet specified above."

Bulletin of the American Museum of Safety, July-August.

Sanitary Survey of Indiana Industries Employing Women Labor.

A survey made during March and April, 1914, of the sanitary working conditions of women of Indiana, by Dr. M. J. White of the United States Public Health Service, is reported in Supplement No. 17 to the Public Health Reports. It included 96 industries located in 13 different cities of Indiana. Such industries as mills, factories, department stores, and laundries were inspected with the idea in mind of making recommendations regarding improvements in ventilating, lighting, dust and fumes disposal, fire-escape facilities, water supply, and home hygiene. Physical examination of employees was found difficult owing to lack of facilities at the places of employment. However, from what little physical examination was made, it was found that none of the workers appeared to be in a particularly poor condition. Absolute evidence of industrial disease was not found among any of the industries. The only probable disposition to mechanic's palsy was noted among the girls working at glove turning.

In regard to ventilation, Dr. White emphasized the fact that a suitable system should be used so that plenty of fresh air could be supplied without draft. The air source should be carefully chosen and the inlets carefully placed so as to avoid stirring up

dust. The necessity of proper lighting is also touched upon. Direct sunlight is injurious to the eyes, as are unshaded electric lamps such as are used on sewing machines.

Where dust and fumes were found it was recommended that proper fans and hoods be used so as to remove these nuisances at the source rather than allowing them to circulate through the air of the room. More efficient means of escape from fire is also emphasized. It is recommended that fire drills and inside fire-alarm systems be installed, and that there be wider aisles between machines wherever possible and more than one exit from the same room.

It was noted, especially among the novices, that there was a tendency to overfatigue, and the recommendation was that convenient places of rest be installed to be used by the women whenever not directly engaged in active duties. It was found that the present laws regarding safeguards on machines were adequate. Three important recommendations are in regard to the adoption of individual drinking cups, individual towels, and liquid soap in place of bar soap. Water supplies both from private and public sources were found generally to be good.

Signs and Slogans.

"Signs and Slogans" is the title of *Accident Prevention Bulletin No. 19*, prepared by the Independence Inspection Bureau of Chicago and Philadelphia.

The first half of the *Bulletin* takes up accident prevention in: Offices, Storerooms, Machine Shops, Carpenter Shops, Foundries, Power Houses, Quarries and Yards. Each receives a short discussion, and special methods to be employed are suggested.

The latter part of the *Bulletin* is devoted to the proper methods to be used in painting and placing signs. Twenty such signs are reproduced in color and the Bureau says in conclusion that it is urged that each company get together standard types of signs for its use, with standard sizes and standard wordings for different locations.

Sanitary Standard for Bakeries.

The National Association of Master Bakers has adopted the following rules:

(1) Building well lighted in every part with natural light, and thoroughly ventilated; air supply kept free from contamination by surface dust.

(2) Floors, walls and ceilings of impervious materials with smooth surfaces and kept clean. Rooms kept free from vermin, and screened against flies.

(3) Plumbing, drainage, etc., ample to remove waste and prevent dampness, and kept in good order. Sanitary toilets, shut off entirely from bakeshop and storage room.

(4) A plentiful supply of pure water. Convenient and adequate washstands and supplies.

(5) Garbage, refuse, etc., stored in tightly covered cans and disposed of quickly.

(6) Machinery, tools and other equipment so made, installed and used as to facilitate cleanliness and safety.

(7) Stables to be disinfected and so located as to prevent odors from them reaching the bakery.

(8) Methods of distribution such as to protect bakery products from contamination between the oven and the home.

(9) A health certificate, showing freedom of all employees from skin diseases, tuberculosis, venereal and other contagious diseases. Spitting and the use of tobacco in the bakery prohibited.

(10) Employees of bakeries to be properly clothed in clean, sanitary garments.

Sidewalk Hazards.

"One hundred and thirty-seven *immediate* deaths due to falls on sidewalks in New York City in 1912 and 1913 are recorded in the Coroner's office. There is no record of subsequent deaths, permanent and minor disabilities resulting from the same causes, but their number must be enormous. The elimination of the causes of these accidents is demanded in the interests of public safety," says the September *Bulletin of the American Museum of Safety*.

"Even a casual inspection of our sidewalks shows astonishingly hazardous conditions. Slippery surfaces such as coal-hole covers, sidewalk or vault lights, curb edgings and vent grades are hazards that are most common and productive of serious accidents.

One casualty insurance company received reports of nine different accidents in one day on one coal-hole cover. The glass surfaces of vault lights and the usual iron borders around them if not protected are always dangerous, but under certain weather conditions are a positive menace to the safety of pedestrians."

"All the conditions mentioned here are unquestionably dangerous. Steps should be taken at once to reduce and, if possible, to eliminate such conditions. While it is easy to point out such hazards, it is extremely difficult to get the proper repairs made. There seems to be no definite jurisdiction in such matters. Policemen are supposed to report slippery coal-hole covers and similar dangerous places. They do report them, but what becomes of the reports? Casualty insurance inspectors call the attention of their clients to dangerous places. Sometimes their advice is taken, but in the majority of cases the property owner is apathetic. Architects and builders could prevent many hazards by proper attention to such details. To insure their consideration *definite* rulings and ordinances should be made covering the requisite protective construction of sidewalks, and jurisdiction in such matters should be clearly defined."

Resuscitation from Mine Gases.

The Committee on Resuscitation from Mine Gases has made an excellent report which appears in *Technical Paper 77 of the Bureau of Mines*, Department of Interior. The Committee appointed in 1912 at the request of Joseph A. Holmes, Director of the Bureau, made an exhaustive study of methods of inducing artificial respiration to those overcome by gases or electric shock. The Bureau makes the following recommendations in administering first aid to those overcome:

"In case of gassing, remove victim at once from gaseous atmosphere. Carry him quickly to fresh air and immediately give manual artificial respiration. Do not stop to loosen clothing. Every moment of delay is dangerous."

The recommendations of the committee are summarized as follows:

"In all cases of suspended or inadequate respiration, as in very slow breathing, the method of artificial respiration which can be most quickly applied should be used at once. In most cases, where good air is present, manual methods of artificial respiration are most immediately useful. Of those the modified prone pressure method already described is best. If there is on the victim a local wound that the prone pressure method may seriously increase, the Silvester method, in which other parts of the body are moved, may be substituted.

In cases of CO poisoning, oxygen should be given instead of air. If the victim is breathing at approximately the normal rate, oxygen may be given very simply by fastening to the face of the victim a mask supplied with straps to hold it in place, fitted with an outlet valve opening to the air, and also fitted with a tube having an inlet valve and connected with a breathing bag. Such masks are on the market. The breathing bag is kept provided with oxygen from a cylinder. If the victim is breathing slowly or irregularly or has ceased breathing, he should be given the oxygen, in the absence of other means, by a manual method of artificial respiration, preferably the prone pressure method.

"In case of electric shock, break electric current instantly. Free the patient from the current with a single quick motion, using any dry nonconductor, such as clothing, rope, or board, to move patient or wire. Beware of using any metal or moist material. Meantime have every effort made to shut off current.

"Attend instantly to the victim's breathing. If the victim is not breathing, he should be given manual artificial respiration at once.

"If the patient is breathing slowly and regularly, do not give artificial respiration but let nature restore breathing unaided.

"In gas cases, give oxygen. If the patient has been gassed, give him pure oxygen, with manual artificial respiration.

"The oxygen may be given through a breathing bag from a cylinder having a reducing valve, with connecting tubes and face mask, and with an inspiratory and an expiratory valve, of which the latter communicates directly with the atmosphere.

"No mechanical artificial resuscitating device should be used unless one operated by hand that has no suction effect on the lungs.

"Use the Schaefer or prone pressure method of artificial respiration. Begin at once. A moment's delay is serious. Proceed as directed in Miners' Circulars 5 and 8 of the Bureau of Mines and on pages 15 to 17 of this paper.

"Continue the artificial respiration. If necessary, continue two hours or longer without interruption until natural breathing is restored. If natural breathing stops after being restored use artificial respiration again.

"Do not give the patient any liquid by mouth until he is fully conscious.

"Give him fresh air, but keep his body warm.

"Send for the nearest doctor as soon as accident is discovered."

The recommendations concerning mechanical apparatus designed to restore natural respiration are:

"Of mechanical devices for artificial respiration, the committee has examined the pulmotor and the Dr. Brat apparatus and disapproves of them, because repeated suction of air from the lungs is not physiological, and if continued is likely to result in injury to the lungs and inadequate inflation; and disapproves of the pulmotor also because the automatic mechanism is so readily disturbed as to be a frail dependence at critical moments.

The committee recommends the apparatus devised by Dr. Meltzer because of its certain action, its freedom from sucking in expiration, and its lightness, cheapness, and simplicity. And the committee suggests that in cases of suspended or insufficient breathing the modified prone pressure method be supplemented as soon as possible by the use of this apparatus."

Medical Examination of Employees.

There has recently been published, by the Advisory Council of the National Association for the Study and Prevention of Tuberculosis a symposium, the topics of which are: The Campaign in Chicago for Medical Examinations of Employees, an efficient system of medical examination of Employees, The Relation of Medical Examination of Employees to the Hygiene of the Working-place and the efficiency of the Working Force, Medical Examination of Employees as a Part of Industrial Insurance.

The symposium concludes with a discussion of the different papers presented and the president of the association says in his concluding remarks, that the problems of each peculiar trade should be worked out separately. This requires careful observation, study and examination, but it is only by some relationship between the medical examiner, the employer and the working man that we can get a solution of the question.

Workmen's Lunch Room.

The Commonwealth Steel Company of Granite City, Ill., wishing to establish pleasant coöperation between the Company and its men, has converted its old Pattern Shop into a Lunch Room at a cost of $12,000. The Company feels that there is a Safety First and efficiency value in good and wholesome food being furnished to workmen.

The Company has prepared a short illustrated paper in regard to their Plant Lunch Room, which contains valuable data regarding costs of foods, methods of operation and maintenance.

Standards of Safety.

The Standardization Committee of the National Council for Industrial Safety has submitted for discussion and consideration, at its annual meeting, Tentative Standards for Safety.

The paper prepared by the Committee considers sixty different sources of danger and gives valuable suggestions to eliminate these dangers.

Some of the more important subjects considered are: General Rules, Boiler Plants, Cranes, Emery Wheels, Engines, Explosives, Stairs and Wood-working Machinery.

The Committee has attempted to study and bring into concrete form procedures which will be practicable to apply.

Industrial Sanitation.

The May and June issues of the *Bulletins of the Milwaukee Health Department* contain the rules which the General Manager of the Erie Railroad Lake Line has issued.

Some of the more important of these are:

"The health of the ship's company is fully as important as the safety of the ship and her cargo and the supervision of the water supply will be the care of the master exclusively and cannot be delegated by him to anyone. Isolated sources of supply and methods of distribution have been or will be provided, and under no circumstances will the tanks be filled from or through any other. The sea-cock will be kept locked and the key in the possession of the master. When water is to be taken the master will give, or send, the key to the engineer on duty, who will personally see that the sea-connection is thoroughly boiled out, by means of the steam connection provided for the purpose, for at least five (5) minutes before opening sea-cock. The engineer will also personally close and lock the sea-cock and return the key to master.

"Water tanks are to be thoroughly cleaned and scrubbed out with a strong caustic solution at least once in each month and the solution drained and flushed away through the distribution service. Except in case of fire, buckets or other vessels are not be dipped into tanks, and every effort is to be made to keep them free from contamination.

"In taking water, masters will exercise due caution with regard to ships ahead and haul courses if necessary to clear their wake.

"Drinking cups or vessels used in common should be thoroughly boiled at frequent intervals or discarded, and the use of water buckets as containers for drinking water should be discouraged as far as possible. When used in fire holds they should be boiled out frequently with the steam hose.

"Natural ice is not to be taken aboard under any circumstances unless artificial is unobtainable and then only when its source is clearly known and satisfactory, and in quantity only sufficient for immediate needs. Ice boxes should be thoroughly scrubbed out after any such supply. No ice at all is preferable to a supply of doubtful quality.

"As corporations and individual employers generally appreciate the need of maintaining sanitary conditions, factory and other sanitary inspectors will become less necessary."

Disease is costly and employers are beginning to appreciate the fact. It is not entirely a question of sentiment. It is equally a question of business.

Accident Prevention Record of the New York Central and Hudson River Railroad.

Since February 1, 1911, not a passenger has been killed on the New York Central and Hudson River Railroad in a train accident. In this period 1,266,654 passenger trains and 819,513 freight trains were operated, day and night, and in all kinds of weather.

In computing passenger train business, it is customary to indicate the number of passengers carried one mile. For instance, a passenger carried fifty miles would be equivalent to fifty passengers carried one mile. There were therefore, 5,286,931,140 passengers carried one mile during this time, or fifty-two times the population of the United States.

Bulletin of American Museum of Safety, September, 1914.